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A Study of the Factors that Influence Early Stages Technology Investment by Food Enterprises

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A study of the factors that influence early stage technology investment by food enterprises

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Dr. Mary McCarthy**

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ABSTRACT

To promote industry sustainability and to catalyze links between publicly-funded knowledge providers and companies, the Irish government has invested significantly in food-orientated research and development. This project aims to facilitate a greater understanding of the motivations and barriers influencing the decision by small and medium-sized food enterprises (SME) to invest in technological innovation, emanating from research conducted in publicly-funded organisations. A critical review of the literature was used to develop a framework for investigating the uptake of technological innovations from sources external to the company. In order to ground this framework within the specific context of the Irish food industry, a series of in-depth interviews were conducted with key food industry representatives (n=7). Building from the literature and exploratory interviews, a postal survey of Irish food SMEs was undertaken (n=399). A response rate of 31.8% (n=117) was achieved. An open innovation scale was constructed from measures of the perceived relevance of academia, support agencies and publicly-funded research. Results of t-tests for independence indicated that companies which showed a propensity towards open innovation were more likely to have performed product [$F(1, 118)=3.9$, $p=0.05$] and process [$F(1, 111)=3.7$, $p<0.001$] innovations in the last three years. The proclivity towards open innovation varied significantly across sectors, with *the prepared-consumer goods* ($\bar{x}$=3.9, SD=0.61) sector scoring a significantly higher open innovation mean than the *others* sector i.e. beverage, seafood and fresh produce ($\bar{x}$=3.4, SD=0.57). Issues arising from earlier research steps were further clarified in a number of follow-up, in-depth interviews, with representatives from SMEs (n=6). By understanding the barriers and drivers to industry uptake of publicly-funded food research, targeted supports can be constructed to facilitate technological innovation within food SMEs, and in doing so, maximise return from the States investment in food-orientated R&D.

DECLARATION

I certify that this thesis which I now submit for examination for the award of _____________________, is entirely my own work and has not been taken from the work of others, save and to the extent that such work has been cited and acknowledged within the text of my work.

This thesis was prepared according to the regulations for postgraduate study by research of the Dublin Institute of Technology and has not been submitted in whole or in part for another award in any Institute.

The work reported on in this thesis conforms to the principles and requirements of the Institute's guidelines for ethics in research.

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Date _______________

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LIST OF ABBREVIATIONS

Abbreviation	Full version
ANOVA	Analysis of Variance
BERD	Business Expenditure on R&D
BIM	Bord Iascaigh Mhara
BRC	British Retail Consortium
BRP	Business Reply Post
BSE	Bovine Spongiform Encephalopathy
CEO	Chief Executive Officer
CIAA	Confédération des industries agro-alimentaires de l'UE - Confederation of the food and drink industries of the EU
CIS	Community Innovation Survey
CSO	Central Statistics Office
CVD	Cardio-Vascular Disease
DIT	Dublin Institute of Technology
DOI	Diffusion Of Innovation
EC	European Commission
EI	Enterprise Ireland
EU	European Union
FA	Factor Analysis
FAO	Food and Agriculture Organisation of the United Nations
FFE	Fuzzy Front End
FIRM	Food Institutional Research Measure
FSAI	Food Safety Authority of Ireland
GDP	Gross Domestic Product
GERD	Government Expenditure on R&D
GM	Genetically Modified
HACCP	Hazard Analysis Critical Control Points
HERD	Higher Education spending on R&D
IBEC	Irish Business and Employers Confederation
ICSTI	Irish Council for Science, Technology and Innovation
IRCSET	Irish Research Council for Science, Engineering & Technology)
IFA	Irish Farmer’s Association
IP	Intellectual Property
IUS	Innovation Union Scoreboard

LSD	Least Significant Difference
ISO	International Organization for Standardization
KMO	Kaiser-Meyer-Olkin
M1	Measure 1
M2	Measure 2
MD	Managing Director
MNC	Multi-National Corporation
NACE	European industrial activity classification
PCA	Principle Component Analysis
NPD	New Product Development
OECD	Organisation for Economic Co-operation and Development
PASW	Predictive Analytics Software
PPP	Product, Process and Packaging
QSE	Qualified Scientists and Engineers
QUAL	Qualitative
QUANT	Quantitative
R&D	Research and Development
ROI	Republic Of Ireland
RTI	Research Technology Innovation
SD	Standard Deviation
SME	Small or Medium-Sized company
SPSS	Statistical Package for the Social Sciences
TDM	Total Design Method
TLI	Third Level Institute
TPP	Technological Product and Process
TRFC	Teagasc Food Research Centre
UCC	University College Cork
UCD	University College Dublin
UK	United Kingdom
UN	United Nations
US	United States

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

Chapter 1
Introduction

1.1 INTRODUCTION

The Irish government has invested significantly in research and development (R&D) in the last decade with the aim of developing a knowledge-based economy. Due to the central importance of the food and drink industry to the Irish economy, one of the desired outputs from this investment is new food products and process technologies, which are aimed at addressing real market needs. However, for a new food technology to deliver benefit, it must first be accepted by both the consumer and industry. This discrete piece of research forms part of a larger study, which examines overall acceptance of novel food technologies by these key stakeholders. The particular focus of this portion of the study is *industry* acceptance of new food technologies.

While the term ‘innovation’ may be open to many differing interpretations in the literature (Schumpeter, 1950; Porter, 1990; Cooper, 1998; Freeman, 2008; Tidd and Bessant, 2009), it is technological innovation which has been the focus of most government support initiatives, and is of particular interest in this research. The established orthodoxy is that innovation is synonymous with competitive advantage, and in turn, the long term survival of a company (Porter, 1985; Trial and Grunert, 1997). Innovation, as a result, affords a means of surviving and thriving in the dynamic agri-food industry (Fortuin *et al*., 2007). Therefore, innovation should logically feature as a key element of food business strategy. However, some have asserted that the food industry has been slow to innovate (Menrad, 2004; Lagnevik, 2003). Despite this, Irish government policy, as outlined in the *Food Harvest 2020* industry vision (Department of Agriculture, Fisheries and Foods, 2010), recognises the significant potential of the Irish agri-food industry to support export-led economic recovery by leveraging innovation and contributing to the development of the ‘smart’ economy.

1.2 OBJECTIVE OF THE STUDY

The study hoped to further the understanding of the technological innovation practices currently occurring in Irish-based agri-food companies (hereafter termed ‘food companies’) and to exploring the elements which drive and inhibit innovation in such companies. In doing so, the study aimed to contribute particularly to the innovation literature, with a particular focus on food companies and SMEs. In order to do this, this research set out to establish the key factors affecting the decision to assimilate technologies by food SMEs. In order to facilitate the understanding of this research question, the following issues will be examined:

1. Perceptions among the Irish food industry regarding the putative benefits and feasibility of uptake of technological innovation
2. Awareness among Irish food companies of the mechanisms which facilitate technological innovation
3. Perceptions of the Irish food industry of the current business environment for companies
4. Current innovation capacity of Irish food businesses

1.3 LAYOUT OF THE THESIS

Chapter two sets the context for this research by illustrating the structure and characteristics of the Irish food industry.

Chapter three explores the complexities of defining innovation and outlines the interpretation of innovation used in this study. To further set the context for this research, a discussion of the level and nature of innovation at national and international levels is presented.

Chapter four discusses the use of the absorptive capacity literature as a framework for understanding the factors influencing uptake of external sources of innovation, and concludes by selecting a test model as a starting point for investigating the research question.

Chapter five describes the mixed methodology used for carrying out the primary research phase of this project. In this, the procedure for undertaking two qualitative research stages, comprising of semi-structured interviews, and the development of the quantitative postal survey are outlined.

Chapter six presents a synthesis of the outcomes from the first round of semi-structured interviews and the relevant existing literature, illustrated as a revised model of absorptive capacity. The hypothesis used to test the component parts of this modified model are introduced at this stage.

In chapter seven the results of the large-scale postal survey carried out among Irish food small or medium-sized companies (SMEs) [1] are presented.

Chapter eight outlines the outcomes from the second round of semi-structured interviews, which were used to further provide additional insight into the results of the postal survey.

Chapter nine gives a summation of the results from the primary research conducted and draws a number of conclusions based on the integration of such results with the prior literature. In addition, recommendations for industry and support-agency representations are provided, with some suggestions for future research outlined.

[1] SMEs are enterprises that employ between 10 and 250 employees, have an annual turnover less than €50million, and/or an annual balance sheet under €43 million (European Commission, 2005)

Chapter 2

Setting the context: the Irish food industry

2.1 INTRODUCTION

In order to facilitate an understanding of how technological innovation can be of benefit to the food industry, it is important to understand the structure and recognise the multi-faceted characteristics of this industry. This chapter presents information on the current structure of the food industry in Ireland and looks at the challenges facing the industry.

2.2 THE IRISH FOOD INDUSTRY

The food supply chain (from farm-to-fork) encompasses three inter-connected segments: agriculture (primary production), food processing, and distribution (wholesaler and retail) (European Commission, 2009). This research focuses primarily on the food processing segment, due to the primary project investment profile of the FIRM grant scheme. However, to understand the interplay of the intricate factors involved in the food industry, it is important to understand where each segment fits into the larger picture.

The food industry is of central importance to the Irish economy. In terms of turnover (€23,281 mn), it is surpassed only by the chemical (€29,024mn), and electrical and optical industry sectors (€32,797mn) (IBEC, 2009). It is the second largest direct employer (41,781 persons engaged), and employs a further 60,000 persons in distribution and services. The Irish food industry is highly export–orientated, with annual exports of food and drink exceeding €7 billion, and destinations focusing mainly on the UK (44%) and continental Europe (34%) (Bord Bia, 2008).

In Ireland, analogously to Europe, the majority of food companies can be classified as SMEs [Central Statistics Office (CSO), 2007]. The majority of food SMEs are Irish-owned and are frequently located in rural communities (CSO, 2007; Avermaete *et al.*, 2004). Sustainable economic growth in local economies is believed to be enhanced by small food firms through creation of employment (Avermaete *et al.*, 2004; McDonagh and Commins, 1999). As a result, they are believed to have a central role in the socio-economic fabric of peripheral regions of the country (Department of Agriculture, Fisheries and Food, 2010). Such regions also rely heavily on other local enterprises, and their long-term sustainability depends on continued high utilisation rate of domestically-sourced raw materials (for example, the food industry uses 90% of outputs by Irish farmers) (Bord Bia, 2008). The preservation of the highly-valued European cultural identity by small food firms is also proposed as a reason for the importance of maintaining the industry (Ilbery and Kneafsey, 1999). However, the preservation of traditional means of production can cause friction with attempts to be innovative. A difficult balance between ensuring profitability and sustainability through innovating and maintain the core values of traditional brands therefore emerges.

The food industry comprises numerous, varied activities (European Commission, 2009). The two sectors that contribute significantly to export activities are dairy products and ingredients, and beef (see table 2.1).

Table 2.1: Irish food and drink exports

	Export 2009 €Mn	Export 2008 €Mn	2008-2009 % +/-
Dairy products and ingredients	2,000	2,202	- 13
Beef	1,400	1,687	- 13
Prepared foods	1,282	1,543	- 15
Beverages	1,071	1,246	- 13
Seafood	303	352	- 15
Pigmeat	290	360	- 9
Edible horticulture and cereals	218	236	- 18
Poultry	180	223	- 11
Sheepmeat	166	166	- 1
Live animals	148	213	+ 44
Total	**7,120**	**8,160**	**- 12**

Source: Bord Bia, 2010a

Previous studies which looked at innovation in the food industry [Le Bars *et al*., 1998 (France); Garcia Martinez and Briz, 2000 (Spain); Avermaete *et al.*, 2003 (Belgium); Menrad, 2004 (Germany)] found a wide divergence in the level and type of innovations reported by companies (table 2.2). These studies will be discussed in more detail in the follow chapters.

Table 2.2: Innovation levels and types reported by European food companies

Cohort	Author	Innovation	Product	Process	Product and Process
Food SMEs in Belgium	Avermaete *et al.* 2003	87.8	69.1*	69.1*	Not given
Spanish food companies	Garcia Martinez and Briz 2000	Not given	13.4	11.9	74.6
Food SMEs in Germany	Menrad 2004	43.9	Not given	Not given	Not given
French agro-food companies	Le Bars *et al.*, 1998	70	Not given	Not given	Not given

*not exclusive to one type of innovation

2.3 Challenges facing the Irish food industry

The food industry is a highly competitive, low margin business, and faces a number of challenges, which are presented in table 2.3 (examples of the challenges facing the industry are divided into those in the economic and operating environment). Increased market liberalisation, reduction in import tariffs and market supports, and removal of quotas (*e.g.* milk quota in 2013) will result in increased competition from foreign manufacturers with lower costs and possibly greater economies of scale (Pegg, 2009). This is further compounded by the rising price of raw materials and increased production and manufacturing costs (*e.g.* energy and wages) (Bord Bia, 2008; Teagasc, 2008). However, there is also an opportunity for food companies to capitalise on the increase in market liberalisation and removal of quotas to enhance their market position. Innovation, either as a means of cost reduction (to remain competitive), or product differentiation (to justify price premiums) can also provide the means of surviving these challenges. The restraint on consumer spending, arising from the world-wide recession, has prompted a rise in popularity of discounter stores and own-label products (Bord Bia, 2009; Leyland, 2009). The demanding conditions of supply associated with supplying own-label products may be best facilitated through process innovations which reduce costs and maximise efficiency.

Evolving consumer trends also creates challenges for the industry (Marcill, 2006; Pegg, 2009). It is often difficult to predict whether trends will be short lived (*e.g.* 'low carb') or enduring (*e.g.* 'convenience foods'). As a result of this uncertainty, the risk associated with investing heavily in the development of a product range or brand to capitalise on such trends is high. However, evaluation of changes in demographics and health status of the population can provide insights into trends that are more likely to last. The shift in the European population age profile to one an increasing proportion of older people, compounded by continually increasing rates of obesity and other non-communicable diseases, provides opportunity for healthy product alternatives (Teagasc, 2008; Blischok, 2009).

Each sector of the industry also has particular weaknesses and strengths, but all have suffered because of the economic downturn (with the exception of the export of live animals) (Bord Bia, 2010b). Additionally, while all sectors were impacted by the weakness in Sterling for the last four years, those for which the UK was the primary market were more severely affected (*e.g.* pigmeat). On an international level, commodity prices (*e.g.* in the dairy and cereals sectors) are subject to continual changes in global demand. More locally, seafood is particularly susceptible to inclement weather. Specific to certain sections of the industry, food scandals can have immense impact, as seen in the dioxin contamination crisis in pigmeat (December, 2008) (Bord Bia, 2010b). Furthermore, prepared consumer goods are particularly open to the shift in consumer spending patterns, resulting in the need for cost reduction measures and product innovation by such companies.

Table 2.3: Examples of current economic and operating environment challenges facing the food industry

Economic environment
Decrease in value of Sterling (Bord Bia, 2008).
Worldwide recession (Bord Bia, 2008).
Ireland banking crisis and ECB-IMF intervention (Bord Bia, 2008).
Slower consumer spending (Bord Bia, 2008)
A rise in popularity of discounter stores (Bord Bia, 2009) and own-label products (Leyland, 2009)
Operating environment
Increased market liberalisation (Pegg, 2009).
Reduction in import tariffs (Pegg, 2009).
Reduced market supports (Pegg, 2009).
Increased competition from foreign manufacturers with lower costs and possibly greater economies of scale (Pegg, 2009).
Rising raw materials prices (Bord Bia, 2008)
Increased production and manufacturing costs (Teagasc, 2008)
Rising cost of energy (Pegg, 2009)
Food scandals (*e.g.* the BSE crisis) (Menrad, 2004).
Socio-demographic shift in consumers e.g. increasing in lifestyle related diseases e.g. CVD and shift in Eutopean poputaion age profile (Blischok, 2009)
Evolving consumer trends *i.e.* demands for:
~ ethical products(*e.g.* fair trade, organic or lower carbon footprint) (Marcill, 2006; Pegg, 2009)
~ more natural products (*e.g.* no-added preservatives or 'clean label') (Hills, 2008).

The need to innovate to deal with these challenges, and survive, in the fast moving consumer goods area, is well recognised by academics, governments and leading international corporations (Porter, 1985; Traill and Grunert, 1997; Department of Enterprise Trade and Employment, 2008; Teagasc, 2008). Food industry-specific studies found that a failure to innovate resulted in competitors gaining significant market share (Traill and Grunert, 1997; Traill and Meulenberg, 2002). The food sectors which are most active in innovation are the dairy, water and soft drinks, frozen foods, biscuits, snacks and cheeses (CIAA, 2008). However, the majority of innovations are process, marketing and management-orientated, and not based on technology-push from basic science (Wijnands *et al.*, 2006). Incremental innovation predominates within the food industry with new products primarily being a variation of older products (Ernst and Young, 1999; Menrad, 2004; Wijnands *et al.*, 2006).

2.4 CONCLUSION

The food and drink industry is of central importance to the European Union (EU), with Ireland representing a prime example of the inter-dependence between farming, food and the economy. Innovation is recognised as a significant driver of economic prosperity (Porter, 1985), and should therefore logically feature as a key element of food company business strategy. However, this industry has been historically slow to innovate, and is characterised by a relatively low level of research intensity (Menrad, 2004).

CHAPTER 3

DEFINING INNOVATION

3.1 INTRODUCTION

In this chapter, as a means of illustrating the complex nature of innovation, a discussion of the varying definitions of innovation is presented. The interpretation of innovation that will be used in this study is also defined. Following this, a discussion of international and national innovation levels is presented.

3.2 DEFINING INNOVATION

Opinions on the definition of innovation are diverse and sometimes conflicting. A number of questions arise when researching interpretations of the term *innovation*. What constitutes an innovation? Are traditional definitions of innovation too narrow in focus? Is innovation limited to technological change? What other forms of change could also be termed innovations? What level of change, or success, is necessary to be termed an innovation? Should definitions of innovation be general in nature or industry-specific? How should the relative nature of innovation be taken into account? (The definitions that form the basis of the following discussion are presented in table 3.1 divided into subsections based on the key premise of the definition *i.e.* general/all-encompassing, relative nature of innovation, and success of innovations. Given the focus of the thesis the table also outlines the evolving nature of the distinction between technological and non-technological innovation, and process and product innovation. Furthermore it provides a number of innovation definitions specific to the food industry. The recently defined ‘hidden innovation’ definitions are also presented in order to facilitate ease of discussion).

Table 3.1: A sample of definitions of innovation found in the literature

Types of classification	
General **Author**	**Definition**
Collins Dictionary (2011)	"something newly introduced, such as a new method or device"
Schumpeter (1950:85)	"The introduction of new goods (…), new methods of production (…), the opening of new markets (…), the conquest of new sources of supply (…) and the carrying out of a new organization of any industry"
Porter (1990:45)	"Improvements in technology and better methods and ways of doing things. It can be manifested in product changes, process changes, new approaches to marketing, new forms of distribution and new concept of scope"
OECD (1992:28)	"The concept of innovation consists of all those scientific, technical, commercial and financial steps necessary for the successful development and marketing of new or improved products (*product innovation*), the commercial use of new or improved processes or equipment *(process innovation*) or the introduction of a new approach to work organisation (*innovation in organization and management*)"
OECD (2005:46)	"An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations."
Buxton (2005:52)	"[innovation is]…far more about prospecting, mining, refining and adding value to 'gold' than it is about alchemy. Rather than focusing on the invention of the 'brand new', one might better strive for creative insights on how to combine, develop and leverage what is already out there, but hidden, or not understood."
Relative nature of innovation	
Rogers (1962)	"An innovation is an idea perceived as new by the individual"
Knight (1967:478)	"The adoption of a change which is new to an organisation and the relevant environment"
Sawhney *et al*. (2006:76)	"creation of substantial new value for customers and the firm by creatively changing one or more dimensions of the business system"
Success of innovations	
Freeman (1982:7)	"An innovation in the economic sense is only accomplished with the first commercial transaction"
Drucker (1985:30)	"The specific instrument of entrepreneurship"
Tidd and Bessant (2005:171)	"Innovation is the successful exploitation of new ideas"
Technological innovation	
OECD (1997)	*Technological product and process (TPP*): the implementation of new or improved technological processes and products
Cooper (1998:497)	*Technological innovation*: "adoption of an idea that directly influences basic output of a firm, which often originates with the technical specialists, trained in hard science"

Non-technological (Administrative/Organisational/Marketing) innovation	
OECD (1997:88)	"all the innovation activities of firms which do not relate to the introduction of a technologically new or substantially changed good or service or to the use of a technologically new or substantially changed process"
Cooper (1998:497)	*Administrative innovation:* "changes that affect policies, allocation of resources, and other social structure factors".
OECD (2005:50)	"An *organisational innovation is* the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations."
OECD (2005:49)	"A *marketing innovation* is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing."
Hidden Innovation	
NESTA (2007:4)	"The innovation activities that are not reflected in traditional indicators such as investments in formal R&D or patents awarded" *Type 1*: Innovation that is identical or similar to activities that are measured by traditional indicators, but which are excluded from measurement *Type 2:* Innovation without a major scientific and technological basis, such as innovation in organisational forms or business models *Type 3:* Innovation created from the novel combination of existing technologies and processes *Type 4:* Locally-developed, small-scale innovations that take place 'under the radar', not only of traditional indicators, but often also of many of the organisation and individual working in a sector
Product vs. process innovation	
Utterback, (1994)	*Product innovation* reflects change in the end product or service offered by the organization *Process innovation* represents changes in the way firms produce end products or services
OECD (2005:48/49)	"A *product innovation* is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics". "A *process innovation* is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software".
Forfás (2006:1)	*Product innovation:* "a new good or service or a significantly improved good or service with respect to its capabilities which can be either new-to-firm or new- to-market". *Process innovation:* "a new or significantly improved production process, distribution method or support activity for goods and services"

Radical vs. incremental innovation	
Cooper (1998)	*Incremental innovation* is the enhancing or extension of existing technology *Radical innovation* involves revolutionary technical and strategic changes within the firm
Garcia and Calantone (2002)	*Incremental* innovation referred to improvements using existing technologies, targeting existing markets, building on the current knowledge and the existing company technology portfolio *Really new* innovations referred to opening either new markets or technology discontinuity, but not both *Radical* innovations were rare and involved bringing a new product to a new market, resulting in the creative destruction or envelopment of current infrastructure (*e.g.* the World Wide Web or steam engine)
Food technology innovation	
Green (1985:231)	"the application of food science to the preservation, processing, and preparation of food and to its packaging, storage and transportation"
Potter and Hotchkiss (1998:7)	"the use of the information generated by food science in the selection, preservation, processing, packaging and distribution, as it affects the consumption of safe and nutritious and wholesome food"
Fuller (2004)	***Product innovation spectrum examples****:* Line extensions (*e.g.* new flavour of crisps), repositioning existing products (*e.g.* oatmeal-containing product repositioned as cholesterol-lowering), new form of existing product (*e.g.* pre-peeled fruit), reformulation of existing products (*e.g.* lactose/wheat-free), new packaging of an existing product (*e.g.* single serving of baked beans), innovative products (*e.g.* dinner kits) and creative products (*e.g.* extruded products)

At a basic level, innovation was defined by the Collins Dictionary as "something newly introduced, such as a new method or device". This is an overtly simple definition, as despite the conflict in the literature as to the authoritative definition, there is general consensus that innovation is a complex, diversified activity, involving both technological and non-technological aspects (Cooper, 1998; Becheikh *et al.*, 2006; Garcia and Calantone, 2002; OECD, 2005).

3.2.1 Innovation: multi-faceted and complex

Schumpeter (1950) and Porter (1990) provided broad ranging, all-encompassing definitions of innovation. For both authors, innovation was not limited to the introduction of new technologies (*i.e.* 'method'/process or 'device'/product innovation as in the Collins dictionary), but also involved changes in business practices, spanning different marketing approaches to new forms of distribution. Nonetheless, disharmony exists between the two definitions. The earlier Schumpeter (1950) version specified ‘new’ as a requisite for innovation, whereas, Porter (1990) indicated that innovations may also include ‘improvements’ to current technology or practices as opposed to completely original concepts. Divergence in opinion, like that seen between Porter (1990) and Schumpeter (1950) in terms of what constitutes an innovation, pervades much of the related literature, making the measurement of the occurrence and breadth of innovation difficult (Garcia and Calantone, 2002). As a consequence of the rather general nature of these early definitions, the empirical measurement of innovation has historically not been clear-cut. Furthermore, details of the level or effort involved in such innovations could not be established. The ensuing confusion reduced the practical applicability of the results of such research for managers interested in following best practice approaches to innovation.

3.2.2 Innovation: Technological vs. non-technological

In an effort to standardise the measurement of innovation and enable international and chronological comparisons, the Organisation for Economic Co-operation and Development (OECD) developed the Oslo Manual (OECD, 1992). The European Community Innovation Survey (CIS), implemented under the Commission Regulation (EC) No 1450/2004, has also adopted measures of innovation derived from this manual. Analogous to Schumpeter (1950) and Porter (1990), the original OECD definition (OECD, 1992) included product, process and organisational aspects, although changes in the approach to marketing were not explicitly cited. The second version of the manual (OECD, 1997), divided innovations into two separate entities: *non-*

technological and *technological product and process (TPP).* This manual focused primarily on TPP, attributing the lack of attention to non-technological innovation to the dearth of relevant studies available at that time. Indeed, guidelines regarding non-technological innovations were relegated to an appendix (OECD, 1997:88). It is clear from the discussion in the related appendix that an uneasy distinction has been drawn between the two aspects. The manual stated that:

> *Organisational change is only counted as technological change when there is a measurable change to a firm's output, either production or sales. Purely organisational change is not to be included in technological change.* (OECD, 1997:88)

This statement implied that 'purely' organisational change involved no "measurable change to a firm's output, either production or sales" (OECD, 1997:88). This begs the question as to why a company would engage in this form of innovation if no economic benefit would result. By the third version (OECD, 2005) this position had changed. In this, they acknowledged that organisational change was inter-connected with technological change, and contributed to the economic performance of companies. Cooper (1998) used the term *administrative* innovation when referring to a similar concept (*i.e.* changes in company policies and structures). He used the phrase, "not related to the basic output of the firm", as a qualifier for this form of innovation, but acknowledged that it related to change in the "organisational characteristics" of the company (Cooper, 1998:498). Therefore, while the qualifier is of use to identify such innovations, it is arguable that the term *organisational* innovation better describes this concept.

Also included for the first time in the OECD definition was the reference to innovations in the form of modifications to "external relations". This inclusion may stem from the resurgence in the interest in innovation using external sources following Chesbrough's (2003) book "*Open Innovation: The new imperative for creating and* *profiting from technology"*. This concept is discussed in more detail in a following section (3.3). Although this may be thought a welcome addition given the focus of this research, the measurement of "the implementation of a new organisational method in a firm's…external relations" may not be particularly enlightening. One of the most important components of the interaction between industry and external sources is the development of the relationship between the two entities (O'Reilly and Henchion 2010), which takes time and effort. Therefore, it is arguable whether sufficient insights into the benefits of such an 'innovation' can be gained from an analysis of whether a change in the management of external relations has taken place or not.

The latest version of the manual, in agreement with Schumpter (1934) and Porter (1990), included marketing as well as organisational innovation, as a complement to technological innovation. Such definitions extend to "changes in… packaging". As such inclusions may have significant technological ramifications for a company, it may be more appropriate to divide marketing innovation into those that relate to the colour or images on the packaging (*i.e.* innovations with a marketing aspect) and those that involve changes of the technology involved in packaging; such *packaging* innovations are discussed in a following section. Marketing innovation, that involves improved customer focus and generating increased market awareness, has particular potential for the food industry. In light of this, it has received increased attention in recent policy documents, such as *AgriVision 2015* (Department of Agriculture, Fisheries and Foods, 2009), the *Food Harvest 2020* (Department of Agriculture, Fisheries and Foods, 2010) and the *Analysis of Ireland's Innovation Performance* (Forfás, 2011).

3.2.3 Innovation: the subjective nature of the concept

Despite the best efforts of the OECD, the issue of the subjective nature of innovation continues to interfere with constructive analysis of such activities. When surveying whether a company is ‘an innovator’, either an objective bystander may decide based on the information available [products portfolio and new product offerings, IP, marketing literature, availing of public grant supports, annual performance reports (if publically available)], or one must rely on the cooperation of the company (Becheikh *et al.*, 2006). Both options are open to bias, as the perception of innovation is inherently subjective, and only takes on meaning when qualified by underlying assumptions. Amara *et al.* (2004) reported that SMEs in particular tended to over-estimate the occurrence and significance of innovation, which has particular relevance to this study.

Although the subjective interpretation of the term innovation has plagued attempts to make comparisons between studies, Rogers (1962) believed that it was the relative interpretation which was of importance when identifying an innovation. He deemed that any idea, practice, process or product that is *perceived* new to the *user* should be termed an innovation. In the food industry, this has implications for both the consumer and the firm, an issue highlighted by Sawhney *et al*. (2006). For example, a radical re-tooling of a company production line may incur significant change within a firm, which may not correspond to perceptible alterations in the finished product, and thus could remain unnoticed by the consumer. Therefore, such an innovation may be perceived as radical by the company but not so by the consumer. As this research attempts to highlight ways in which innovation in food companies could be supported, the perspective of the firm as to whether they had implemented an innovation was of particular interest. The acceptance of leading edge food innovations by consumers was studied in detail by the partner project of this research, and is an issue that must be taken into consideration by companies when deciding whether to invest in innovation. This is particularity true for more radical concepts. Consumers have been found to be more reticent about the acceptance of novel technologies applied to foods in comparison to other possible applications, such as medical treatment (*e.g.* rejection of GM crops vs. acceptance of GM insulin; rejection of irradiation of foodstuff vs. acceptance of sterilisation of medical instruments using irradiation) (Eurobarometer, 2010).

3.2.4 Innovation vs. invention

In the original version of the Oslo manual, the definition of innovation included references to “successful development” and “commercial use”. In contrast, the most recent manual referred only to the “implementation” of a change in technology or practice and thus avoided distinguishing between successful and unsuccessful innovations. In line with the original definition, Tidd and Bessant (2005:171) insisted that success be a qualifier for an innovation (“an innovation is the successful exploitation of new ideas”). However, the question then arises; at what point is an innovation deemed successful? Is it on adoption by a firm; on commercialisation; or on a return of economic benefit to the firm? Schumpeter (1994) held that innovation had been accomplished only when the first commercial transaction involving the modified process or product had taken place. In contrast, Garcia and Calantone (2002:112) posited that “an invention does not become an innovation until it has progressed through production and marketing tasks and is diffused into the marketplace”. The level of diffusion into the market place was not specified and may be difficult to quantify. Therefore, the Schumpeter interpretation offers a more practical approach to this issue, but conspicuously excludes intangible assets such as patent applications, which may deliver future economic benefit to the company (and if successfully awarded, represent the acme of innovation). Perhaps in recognition of this, discoveries that have not achieved commercial success have been termed ‘inventions’ by some authors (for example, Garcia and Calantone, 2002). To follow this logic, the commercial success of pre-washed, chopped lettuce ensures its classification as an innovation, whereas, due to its commercial failure, the first GM tomato (*FlavrSavr*) remains classified as an invention (a somewhat anachronistic situation). This has particular relevance for research emerging from publicly-funded research and implies that discoveries that remain in the lab and are not transferred into industry remain inventions as opposed to innovations.

Using the term ‘commercial success’ as a qualifier for an innovation has additional limitations: it excludes changes in practice that remain within the company and reduce costs, and also it negates the extensive R&D input which may have preceded an unsuccessful new product or process. Indeed, Buxton (2005) suggested moving away entirely from ‘brand new’ innovations and focusing on the possible value-adding aspect of innovation through combining, developing and leveraging current resources. This interpretation of innovation is aligned with the work of the UK National Endowment for Science, Technology and the Arts (NESTA) on the potential from hidden innovation (see below). By using the term ‘implementation’, the OECD take the perspective of the organisation as to whether an innovation was of benefit, and in doing so, provide a practical approach to measuring innovations in both companies and research institutes.

3.2.5 Innovation: Recent developments in measurement of the concept

Some of the most recent developments in the study of innovative practices have related to the concept of 'hidden innovation'. Since the third edition of the Oslo Manual was published, NESTA have been further developing this concept as a means of encapsulating the important contribution this form of innovation makes to industries that are traditionally seen as low innovators (NESTA, 2007). NESTA (2007:4) identified four different types of 'hidden' innovation that, despite not being highlighted by the traditional measures, were felt to be making a significant contribution to the "real practice and performance of a sector". These included innovations that were similar to activities that could be measured by traditional measures, but were not currently assessed (termed Type I; *e.g.* a poor history of intellectual property (IP) protection use in an industry can result in patentable innovations going un-protected). Type II innovations were identified as those that did not have a basis in major scientific and technological advances (*e.g.* a number of smaller suppliers collaborating to supply a multiple). The third type is aligned with Buxton's (2005) opinion regarding the leveraging of existing technological capabilities to create new value (*e.g.* the use of existing IT systems to facilitate on-line shopping by retailers directly to consumers). Finally, the fourth type refers to innovations which remain local to an area (*e.g.* producers collaborating to form a local market). When examined in more detail, type I and III arguably describe technological innovations at differing levels of innovativeness. Similarly, type II and IV are aligned with the OECD organisational innovation definition, but again at varying levels of innovativeness. NESTA (2007:5) believed that hidden innovation was "often more about absorbing ideas than creating new ones". Given the focus of this research on adopting technologies from sources external to the firm, this concept had particular relevance to this study.

3.3 LEVEL OF CHANGE INVOLVED IN INNOVATION

The shift in focus to "improved" (Porter, 1990), as opposed to "new" (Schumpeter, 1950), as a qualifier for innovation is evident in more recent definitions (OECD, 2005; Buxton, 2005; NESTA, 2007). When identifying technological innovations, the Oslo Manual (OECD, 2005) stipulated that a product or process be at minimum 'significantly improved' (*i.e.* an existing product must have a significantly enhanced or upgraded performance). The manual also stated that the improvement does not have to be 'new to the world' (*i.e.* radical) to be included as an innovation. This is aligned with Buxton's (2005) opinion that it was the value-creation aspect of change that constituted an innovation as opposed to the newness of the discovery.

The definitions discussed previously are generally assessed using a binary approach as to whether a company had introduced an innovation or not. However, it has been suggested that this method does not provide meaningful information as to the levels of innovation being undertaken by companies (Amara *et al.*, 2004). In fact, all innovations are assumed to be of the same magnitude and companies are deemed either innovators or non-innovators. As a result, the antecedents and outcomes of differing levels of innovation could not be established. Studies that gather this form of data provide limited insight into the nature of innovation, which arguably reduces their potential to inform effective policy (Amara *et al.*, 2004). Therefore, an extra step to discern the level of innovativeness is required (Garcia and Calantone, 2002; Becheikh *et al.*, 2006).

One approach suggested to achieve this is to investigate the degree of structural and strategic change a company must undergo to incorporate the innovation (Lawless and Anderson, 1986; Cooper, 1998). Cooper (1998) contended that incremental innovation was the enhancement or extension of existing technology (*e.g.* product line extension – new flavour of fruit yogurt; addition of extra ingredient – cereal with nuts/fruit pieces). Conversely, radical innovation involved revolutionary technical and strategic changes within the firm (*e.g.* move from vinyl to CD) (Cooper, 1998). Garcia and Calantone (2002) also provided an intermediate level of "really-new" innovations (i*.e.* new products to existing markets; *e.g.* extension of Mars™ into an ice-cream range) or existing concepts to new markets (*e.g.* international spread of American cuisine through franchises such as McDonalds)]. While more radical innovations are thought to be important in improving competitive advantage and creating and accessing new markets for companies (McDermott and O'Connor, 2002; Amara, 2004), they also involve significant uncertainty about the future (arising from the firm's incomplete knowledge) and greater risk than incremental innovations (due to usually higher levels of investment) (Matploulous and Vlachopoulou, 2008). This perception of risk is exacerbated by the documented high level of product failure, which is reported to range from 48% to 99% of food and beverage products launched (FAO, 2006). A number of high profile product failures followed significant R&D investment (*e.g.* Guinness Light, New Coke, Crystal Pepsi). However, there have been some notable successes with more radical food concepts which have resulted in high returns from investment (*e.g.* introduction of Valio's cholesterol-lowering spread and the McDonald's burger; commercialisation of Kiwi fruit production and of frozen foods). Indeed, Hoban (1998) reported that while more incremental innovation such as 'line extension' only had a success rate of 28%, 'newer' product types had a much higher rate of success (47%). While radical innovations have their advantages, it can be a risky strategy in food companies which are constrained by low margins or a lack of knowledge of the market. As mentioned previously, consumer acceptance of radical concepts relating to food can also be limited (Eurobarometer, 2010). Another approach to differentiate levels of innovation is to look at whether they involved “substantial scientific and engineering expertise” (Romijn and Albaladejo, 2002:1058). This is aligned with Cooper’s definition (1998), in which he linked technological innovation to scientific research.Traill and Grunert (1997) were of a similar opinion, and maintained that R&D was a key driver of technological change in food companies. Due to the link between R&D and more radical innovations, this may be an effective way of identifying innovations with a greater degree of novelty. However, as described above with reference to hidden innovation, this may also miss a significant portion of the innovation which creates value in an industry.

Nevertheless, the subjective nature of the interpretation of innovation poses a challenge to the easy classification of developments as being incremental or radical. Knight (1967:478), however, was of the opinion that being new to “the relevant environment” was a prerequisite of an innovation. This is similar to the CIS definition of ‘new-to-market’ innovation, which is predicated on the basis that the company made the change before its competitors. In contrast, a ‘new-to-firm’ innovation can be already available from competitors and still be termed an innovation if it did not exist in the company previously. From the perspective of a company, an innovation that is new-to-market, and involves significant resource input, can be seen as ‘radical’. As a result, an innovation may be radical to one company and incremental to another, depending on the prior competencies of the respective companies (Romijn and Albaladejo, 2002). The widespread use of this means of differentiating levels of innovativeness in Europe facilitates ease-of-comparison across innovation studies. Although it is not an objective measure of innovation, it takes into account the perspective of the firm and how much effort was required on their behalf to innovate. Therefore, it is arguable that it is a useful method of identifying ways to support such companies.

3.4 Technological innovation

Due to the focus of this project, food technological innovation was of particular interest. Looking specifically at food technological innovations, the definitions proposed by Green (1985) and Potter and Hotchkiss (1998) are alike. Both highlight how food technological innovations use knowledge gained thorough science to improve the formulation, processing and preservation, and packaging and distribution, of the food product. However, both definitions are manufacturing orientated and exclude the organisational innovations required to facilitate such innovations.

Conventionally in the food industry technological innovations have been divided into *product* and *process* technological innovations (Triall and Grunert, 1997). The latest Oslo manual (OECD, 2005) takes a similar approach and makes clear distinction between the two types of technological innovation. Porter (1990) highlighted the importance of differentiating between the two types as companies pursued different innovations depending on which strategies they have adopted. Cooper (1998) concurred with this, stating that if a company's primary focus was on cost reduction and cost leadership, then process innovations were more likely to occur. Implementing processes that are more efficient can result in lower costs (*e.g.* introduction of automation to reduce labour costs or achieving higher throughput by increasing scale). In contrast, if the focus was primarily on product differentiation and maintaining a strong brand image, product innovations were more likely to be implemented (*e.g.* addition of ingredients that can give rise to the use of a health claim, reformulation to be lower in fat or gluten-free). Traill and Meulenberg (2002) echoed this observation, having found that similar motivations were influencing the predominant type of innovation occurring in the food companies. Although this is a good starting point, in reality it is difficult to completely separate product and process food innovations as one may necessitate or give rise to the other (*e.g*. automation of a processing line may increase efficiency and provide extra scope for processing new lines of product). Likewise, the adoption of a new technology may provide the opportunity to increase product differentiation [*e.g.* introduction of High Pressure Processing (HPP) can reduce the need for preservatives and thus a product could be marketed as a more 'natural' alternative (Hite, 1989; Rastogi, *et al.,* 2007)].

The OECD (2005) and CIS (Forfás, 2006) definitions of *product* innovation refer to both goods and services. This is reflective of the increasing recognition of the contribution of the service industry to the economies of developed countries (NESTA, 2007). The work presented in this thesis primarily focused on food manufacturers, and therefore the aspect of 'goods' was of particular interest. Similar to the OECD definition which specified "changes in characteristic of intended use", Utterback (1994) used the qualifier of "change in end-product offered by the organisation" to indicate a product innovation. However, the OECD (2005) definition may be more relevant for technologies emanating for research institutes, as the product may be in an early stage of development and may require further improvement when reaching the company (*e.g*. a formulation for lower salt products which has to be tailored to the companies own product range). Fuller (2004) provided a spectrum of possible food *product* innovations, from basic line extensions to more innovative and creative products. The level of risk and reward involved in such innovations was discussed previously.

Alternatively, according to the OECD (2005) and CIS (Forfás, 2006), *process* innovations were stipulated to refer to changes in "production or delivery methods" with particular reference to "techniques, equipment and/or software" (OECD, 2005). The OECD definition may be applied to a broad range of industries; however, Fuller (2004) provides a more industry-specific description of food processing. In this, he outlines how food *process* innovations can occur at any stage of the product development cycle, from new or improved methods of ingredient extraction to novel methods of food processing (*e.g.* high hydrostatic pressure, irradiation). Again, the manufacturing slant is evident in this definition, reinforcing the importance of this attribute from a food company perspective.

Innovating through food packaging alterations and new food packaging systems are also thought to be important avenues for food companies (*e.g.* from an environmental, marketing, convenience and a food safety prospective (Earle, 1997). Although included in the OECD (2005) definition of marketing innovation, packaging innovations may have significant technical ramifications for food companies, and thus many of the same challenges that arise with product and process innovations are relevant. Indeed, food packaging innovations were included as a vital component of Jul's (1984) breakdown of food technologies (originating in the study of frozen foods): the nature and composition of the *Product* itself, the *Process* it underwent, and the type of *Packaging* in which it was frozen and stored, were identified as the most important factors in determining shelf life. The PPP triad has since been extended to chilled foods and other methods of food processing (George, 2000; Winger, 2000). Due to the importance of packaging innovation in this context, they were also included as examples of technological innovations in this research.

3.5 INTERPRETATION OF INNOVATION FOR THIS PROJECT

Despite the divergence in scope among the different definitions discussed, the preponderance of evidence concurs with the belief that innovation is a multi-dimensional concept. Hence, in this study, innovation will be characterised by a number of different components. These will include the type of change needed to occur in the company (technological or organisational or marketing), the magnitude of required change from the perspective of the company ('new-to-market' or 'new-to-company') and the aspect of the company that is involved in the innovation, in particular relating to technological innovations (product, process or packaging). In addition, in order to ensure that companies fully comprehend the organisational aspect of innovation (which is a relatively new concept in innovation surveying) a further breakdown of organisation innovations will also be provided (raw material supply, business models, distribution approaches). As we endeavour to highlight ways to better support innovation in food companies, it is the company's perspective as to the success of the innovation that is of particular interest. The transfer of discoveries from research organisations to industry is of particular interest. Therefore, if a company indicated they had taken on an innovation from an external source, it was taken to be a 'successful' innovation from the point of view of the company and thus in line with the definitions of innovation requiring a successful transaction to be termed an innovation.

3.6 PROBLEMS WITH TRADITIONAL MEASURES OF INNOVATION

NESTA's work on 'hidden' innovation was motivated by the poor performance of the UK when measured using the conventional indicators of innovation (*i.e.* R&D expenditure and patent counts). Other authors have also recognised imperfections in the conventional innovation measures such as those that motivated NESTA to investigate hidden innovation. Kleinknecht *et al.* (2002) and Becheikh *et al.* (2006) contended that R&D spend was a flawed measure for technological innovation as it cannot be extrapolated to give an indication of innovation outputs, and excludes other innovation inputs (*e.g.* capital expenditure on new process equipment). Patent applications are also seen as a flawed measure for the following reasons: they exclude non-patented innovations; they may not be reflective of economic value; there is a different propensity to patent across different sectors and they can be purposely misleading, as firms are known to make strategic decisions to deceive competitors (Kleinknecht *et al.*, 2002; Romijn and Albaladejo, 2002; Becheikh *et al.*, 2006). As an alternative, Kleinknect *et al.*, (2002) advised measuring innovation outputs (*e.g.* product/process innovations) as it is not possible to ascertain whether the original innovation investment achieved the intended goal, when focusing solely on inputs (*e.g.* R&D spend or capital expenditure). Similarly, Avermaete *et al*. (2003) and Traill and Grunert (1997) stressed the importance of including measures of organisational innovation when assessing this activity in smaller companies; it was felt that focusing solely on R&D-driven innovation would not give a representative picture of efforts being made by the company. The focal point of the work presented in this thesis was technological innovation due to the original remit of the project and the integration with a further project involving consumer acceptance of technological innovation. However, it is acknowledged that organisational and marketing innovation can facilitate and highlight the need for technological innovation (OECD, 2005), and is therefore an integral part of the innovation process.

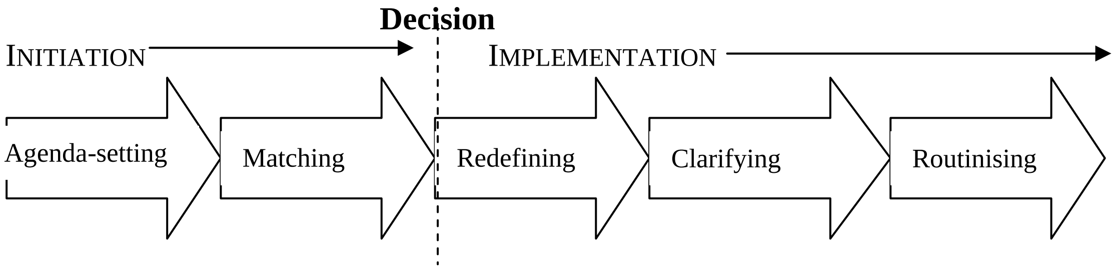
NESTA suggested that an ‘industry-relevant’ innovation index would be best able to identify the innovations that were actually making a difference to a specific industry. This would greatly improve policy development, as it would highlight areas to target more efficiently. While such indexes have been created for some industries (such as oil production, retail banking and construction), a food industry-specific index remains elusive. It is hoped that studies such as the work presented here one can contribute to the development of such an index. By moving to a measurement method that incorporates such suggestions, in addition to those highlighted by the hidden innovation work, it is probable that a very different picture of the level of innovation in food companies would emerge.

3.7 THE INNOVATION PROCESS

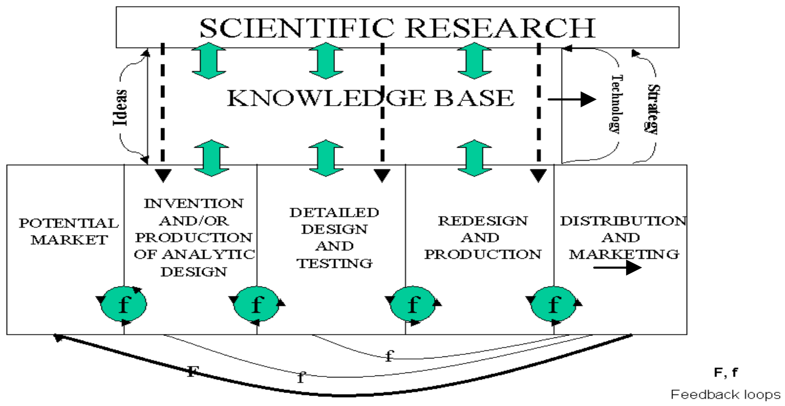
The process by which innovation occurs has been the focus of much debate in the academic literature. Examples of models used to illustrate this process are presented in table 3.2.

Table 3.2 Models of the innovation process described in the literature

Rogerian innovation process (Rogers, 1962)

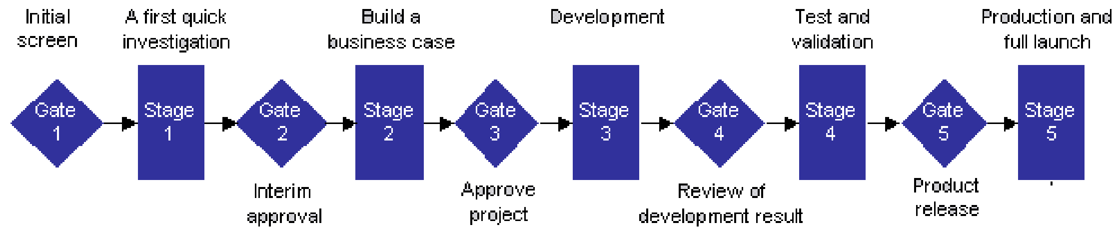


Chain linked model (Klein and Rosenberg, 1986)



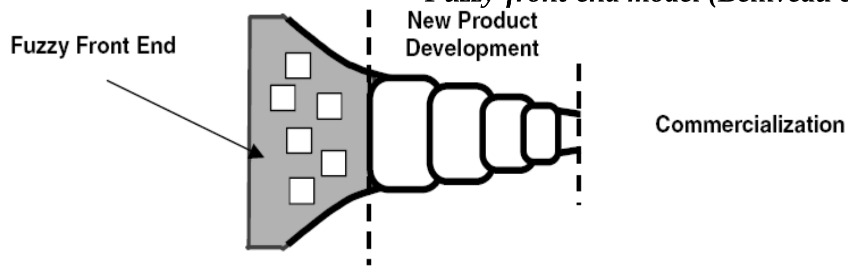
Source: Henchion *et al. In press* A

Stage-gate process™ (Cooper, 2001)



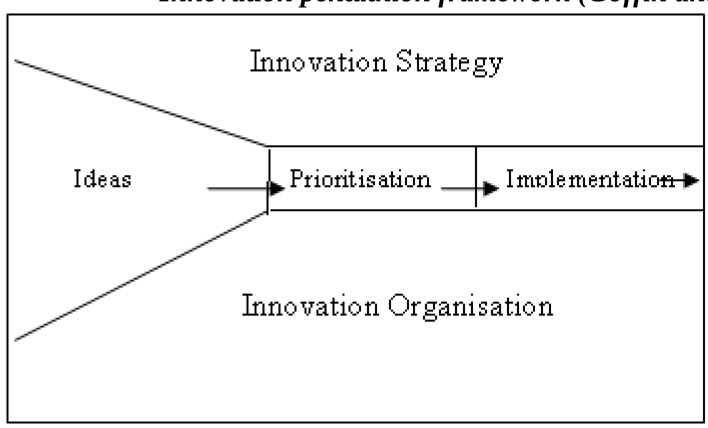
Source: Masterson's Consulting (2011)

Fuzzy-front-end model (Belliveau et al., 2002)



Source: Belliveau *et al.*, 2002

Innovation pentathlon framework (Goffin and Mitchell, 2005)



In early literature, the innovation process was believed to be a "smooth, well behaved linear process" with research leading to development, production, and finally, marketing (Bush, 1945 in Kline and Rosenberg, 1986:276). However, this belief was subsequently criticised as unreflective of the "the real world of inadequate information, high uncertainty, and fallible people" (Kline and Rosenberg, 1986:286). Following this censure, more complex models have been developed in which feedback loops attempt to cycle information back to the earlier stages of the process, in order to inform and improve decision-making [*e.g.* Cooper, 2001 (stage-gate); Kline and Rosenberg, 1986 (chain-linked model)]. A further criticism of the early models was the lack of allowances made for the impact of the business environment (*e.g.* economic climate, market demand) on innovation. As it was recognised that the innovation process did not occur in isolation, but in an environment with many influencing factors, models evolved which accounted for this (Goffin and Mitchell, 2005).

The Rogerian model has been used extensively in the literature (Abbey and Dickson, 1983; Hurley *et al.*, 1998; Sunding *et al.*, 2001; Lee, 2004). In this model, the innovation process is depicted in five stages, the first two of which have been termed innovation *initiation* stages (agenda-setting and matching), and the second three stages identified as *implementation* stages (redefining/restructuring, clarifying and integration in company routines). When examined in more detail, it is apparent that the initiation stage is similar to the process described by Belliveau *et al.* (2002) in the FFE model. Here, many ideas appropriated from external and internal sources were collated and screened: the most viable were carried on to the next stage (Belliveau *et al.*, 2002). This narrowing of focus was illustrated as a funnel. This funnel design was also found in the Goffin and Mitchell (2005) 'pentathlon framework'. Again, a multitude of ideas are sourced and then prioritised depending on their potential for the company, before being finally implemented. However, the 'innovation process' concept was further developed to include the influence of the business environment, the importance of which had grown in recognition (Goffin and Mitchell, 2005). In the pentathlon framework, *innovation strategy* refers to the plan for innovation implementation, whereas *innovation organisation* refers to the culture of innovation within a company which hinders or helps innovation efforts. Both of these elements will be further discussed in Chapter 3. The initiation stage of Roger's model includes an element of matching (*i.e.* evaluating options). This is akin to the *scoping* stage of the Stage Gate Model™

(Cooper, 2001). In contrast to the other models, in which the ultimate aim is marketing and distribution (*e.g.* chain-linked model, FFE model), the Rogerian model attempts to take the perspective of the company. In the implementation stage, it focuses on the change of routine required in the company in order to integrate the innovation into common practice.

The various innovation models discussed can be applied to innovation ideas sourced internally and externally to the company. However, smaller companies are often limited in their ability to generate ideas internally by a low level of in-house technical capacity and commercial wherewithal, and must therefore utilise external sources (Batterink, 2009). Nevertheless, due to a continually increasing complexity of available information it is becoming more difficult for any one firm to research and develop every possibility (Lane *et al.*, 2006).

Chesbrough's (2003) *open innovation paradigm* is centrally defined by attributing equal importance to both internal and external knowledge sources, and subscribes to a business model that stresses the conversion of innovative ideas into commercial realities. This is in contrast to the *closed innovation* model, in which innovations are researched, developed and commercialised using resources internal to the firm (an option not best suited to the strained resource of smaller food companies) (Chesbrough, 2003). While a considerable number of studies have been published under the guise of *open innovation* (reviewed in Chesbrough *et al*. 2008, see also Sarkar and Costa, 2008), more recent re-evaluations of the area have questioned its impact (Trott and Hartman, 2010). Trott and Hartman (2010:715) believed that this 'new paradigm' is "the repackaging and representation of concepts and findings presented over the past forty years within the literature on innovation management". They pointed to the long-established work of Allen (1969) and Rothwell and Zegveld (1985) that emphasised the need for external linkages, and to Tilton (1971) and Mowery (1983) who showed companies that perform their own R&D were better able to benefit from externally available information, as they have developed the skills necessary to recognise the value of external information and take it on board. Arguably, the open innovation concept is very similar in nature to the theory of absorptive capacity, a term coined by Cohen and Levinthal in their seminal papers (1989, 1990, and 1994). In line with this, NESTA (2007:6) suggested that:

> *It is more efficient and effective to improve a sector's capacity for innovation than to support the creation of specific innovations. Alongside improving a sector's generation of innovation, this will mean increasing its absorptive capacity to draw innovations in from elsewhere, and strengthening its internal processes for developing and diffusing them.*

Therefore, the literature surrounding absorptive capacity was deemed an appropriate frame for understanding the factors influencing uptake of external sources of innovation and will be further developed in Chapter 3.

3.8 DRIVERS AND BARRIERS TO TECHNOLOGICAL INNOVATION FOR THE FOOD INDUSTRY

Despite the varying interpretations discussed, the established orthodoxy is that innovation is synonymous with competitive advantage and firms that do not engage in innovation have been reported to have a higher rate of failure (Chesbrough, 2003). Externally to the company, Porter (1985), for example, contended that innovation was essential in achieving sustained competitive advantage, and that prevention of competitor encroachment would be best achieved by presenting "a moving target…by investing continually to improve (the company's) position" (Porter, 1985:20). Innovation provides the momentum for this 'moving target'. Menrad (2004) opined that in such a highly competitive industry, product innovation could confer competitive advantage to food companies by establishing differentiation. Driven by consumer demand, technological innovation also contributes to product diversification and accordingly results in increased consumer choice (European Commission, 2009). Traill and Grunert (1997) were also of the opinion that innovative products and processes, based on consumer demands, supply real market needs and could result in high return for the industry.

Internally to the firm, Porter (1990) also hypothesised that a significant technological innovation can result in a firm concurrently lowering costs and enhancing market differentiation, considerably increasing their competitive advantage. Additionally, technological innovation can result in a reduction of variable costs, increased capacity and output quality (Beaumont, 1998). Innovation based on food R&D is generally recognised as having the potential to increase both the efficiency and productivity of the food sector through technological progress (European Commission, 2009). Innovation, as a result, affords a means of surviving and thriving in the dynamic agri-food industry (Fortuin *et al*., 2007).

However, innovation can present a number of challenges for companies, as the following quote from the *Economist* demonstrates:

> *According to Schumpeter, any innovation naturally causes booms and busts, because every new product market generates some uncertainty. This causes people to invest too much in the new product, but as the uncertainty is resolved the bubble pops (Anonymous, 2009a).*

The uncertainty caused by innovation, compounded by delays in return on investment, can be difficult for low margin food companies to absorb. In addition, the relative cost of innovation is higher for smaller companies than larger companies, given the constraints on resources within the former (Laforet, 2006). Ill-considered innovations can dilute brand image (*e.g.* Colgate Kitchen Entrees, ‘New’ Coke), resulting in significant resource wastage, which is a particular issue for SMEs with tight margins. Therefore, it is important to identify projects with specific value for the company and prioritise innovation efforts accordingly (Cooper, 2004).

3.9 Innovation internationally, nationally and in the food industry

3.9.1 Innovation on an international scale

The most recent Innovation Union Scoreboard (IUS) (formerly the European Innovation Scoreboard) placed the EU27 behind both the US and Japan, but ahead of Brazil, China, India and Russia in terms of innovation performance (UNU-MERIT, 2011). This scoreboard draws from a number of different indicators to give a more complete picture of national innovation capacity[2]. However, the gap between the EU27 and Brazil and China was acknowledged to be steadily closing. The US innovation performance lead was attributed in part to high-level universities, which have strong links to the private sector, in addition to high levels of successful commercialisation of technological knowledge. In contrast, the Japanese success was credited to the high levels of Business Expenditure on R&D (BERD).

Internationally harmonised R&D expenditure statistics have been used since the 1950s to facilitate cross-country and cross-industry comparisons (*i.e.* the OECD, Frascati-Manual) (Kleinknecht *et al.*, 2002). On a global scale, Europe is currently behind the US and Japan in terms of investment in R&D as a percentage of GDP (OECD, 2010). However, public R&D expenditure now exceeds both of these countries (UNU-MERIT, 2011). As part of the Lisbon Strategy, Europe set targets to raise investment in R&D to 3% of GDP by 2010 (European Commission, 2008). By 2008, this had reached 1.8% of GDP (latest available figure, OECD, 2010).

Looking specifically at human capital, the level of new doctoral degrees continued to be higher in the US than the EU27. Furthermore, although the current level

[2] This scoreboard accounts for three different aspects of innovation: *Enablers*, *i.e*. the basic building blocks which allow innovation to take place (human resources, finance and support, open, excellent and attractive research systems); *Firm activities* which show how innovative Europe's firms are (firm investments, linkages & entrepreneurship, intellectual assets); and *Outputs* which show how this translates into benefits for the economy as a whole (innovators, economic effects) (EC, 2011).

of new PhD's in Japan was below the EU27, the rate at which they were increasing was significantly higher. In 2008, it was recognised that nearly 80% of world researchers worked outside the EU (European Commission, 2008). In terms of numbers of patent applications, the lead held by the US was found to be reducing. However, the Japanese performance was growing at a high rate (5.9%), and licences and patent revenues continued to exceed European rates of return on investment (UNU-MERIT, 2011). While Brazil and China remain behind the EU27 for the vast majority of indicators, they have intense relative growth when compared to the EU27. However, as discussed previously, R&D expenditure and patent counts are now recognised to portray a limited picture of innovation in many countries (in particular those dominated by service industries) and industry sectors (*e.g.* industries with high levels of SMEs).

3.9.2 Innovation on a national scale

The importance of innovation for the national economy has been recognised by a number of reports and policy documents that have been compiled by the Irish government and relevant bodies (Forfás, 2004; Department of Agriculture Fisheries and Food, 2005; Department of Enterprise Trade and Employment, 2006; Department of Enterprise Trade and Employment, 2008; Forfás, 2008; Forfás, 2010; Department of Agriculture, Fisheries and Food, 2010; Government of Ireland, 2010). The national strategic aim is for Ireland to become a knowledge-based economy, and to this end, the government, under the National Development Plan (2007-2013), committed €20 billion to enterprise, science and innovation (Government of Ireland, 2007).

Ireland's innovation performance was deemed to be encouraging from an international perspective in a recent analysis (Forfás, 2011). This was attributed to the high number of most companies engaging in innovation activities, in combination with high levels of innovation expenditure. However, this positive trend was not true for small indigenous companies where a number of weaknesses were found to prevail (*i.e.* lower returns from innovation investment, lower levels of engagement in innovation). This is particularly worrying due to the high proportion of indigenous SMEs operating in the food industry.

Irish expenditure on R&D continued to be below that of the EU average (1.35% GDP) (European Commission, 2008). When compared to Finland (a comparable country to Ireland in terms of population size and economic structure), 3.4% of Finnish GDP was committed to R&D between 2000-2005 (Storgårds, 2009). Low levels of BERD contributed to this (see table 3.3) (Forfás, 2010a). However, improvements in recent years in higher education spending on R&D (HERD) have put Ireland ahead of the EU and OECD average in this respect (see table 3.3) (Forfás, 2008). Furthermore, the IUS placed Ireland third in Europe in terms of level of human resources available (mostly attributed to the percentage of the population with a completed tertiary education). Additionally, Ireland was well above the EU average in terms of an "open, excellent and attractive research system" (UNU-MERIT, 2011:13). However, access to finance (particularly low availability of venture capital) and protection of intellectual assets (most notably low levels of patent applications) were significant weaknesses highlighted in the innovation system; as a result, Ireland was relegated to the position of 'innovation follower'. Finland, in contrast, was termed an 'innovation leader' due to its exceedingly high scores in the "top 10% most cited scientific publications worldwide", public-private scientific co-publications and patent applications (UNU-MERIT, 2011:48).

Table 3.3: Expenditure on R&D in Ireland in comparison to the EU and the OECD

	BERD	HERD
Ireland (% of GNP[3])	0.88%	0.48%,
EU average (% of GDP)	1.2%,	0.42%,
OECD average (% of GDP)	1.6%	0.39%)

BERD = Business Expenditure on R&D
HERD = Higher Education Expenditure on R&D

3.9.3 Research and development in the food industry

3.9.3.1 Publicly-funded research and the food industry

Across Europe, expenditure on food R&D is generally low, at 0.37% of food and drink output (CIAA, 2009). Ireland is no exception: government-funded R&D in the Irish food sector is less than half the EU average, and just over a third of the OECD average. This level of expenditure on R&D is far below that committed by high-tech, high-return industries such as pharmaceutical, biotechnology, automobile and chemical industries. It is comparable to the amount invested by the textiles, wood and basic metal industries (Wijnands *et al.*, 2006). This may be due to the perceived limited returns from investment in food research and low margin nature of the food industry, and this will be investigated further in the primary research stage. In an effort to reconcile the historically low levels of investment, under the National Development Plan (2007-2013), €641m was allocated to agri-food research (IBEC, 2009).

Since 2000, the Food Institutional Research Measure (FIRM) grant scheme has been used as a channel for food research funding by the NDP (Department of Agriculture, Fisheries and Foods, 2007). The original remit of FIRM was as a public good research measure, in which the funding of fundamental research was expected to form the basis for in-house pre-commercial and commercial research, which could not have occurred without the initial research taking place. It was believed that without such research, the competitiveness [*e.g.* the new product development (NPD) and R&D

[3] GNP is often used in Ireland in preference to GDP as for a number of years the "amount belonging to persons abroad has exceeded the amount received from abroad" (CSO, 2011).

capability] of the Irish food industry would be compromised (Department of Agriculture, Fisheries and Foods, 2007).

However, it was recognised over time, that a balance between free dissemination (*i.e.* public good research), and legal protection and exploitation of IP from FIRM funded research was needed in order to ensure maximum value from the R&D-generated knowledge. Indeed, it was acknowledged that, while it was important to grown the Irish academic base and raise the profile of Ireland as a place with excellent research, it was also imperative to ensure application of the results from that investment. In this way, the return on investment could be maximised and could contribute to future economic and social development by generating wealth and boosting competitiveness (ICSTI, 2004). In an attempt to formalise this shift in thinking, the *National Code of Practice for Managing Intellectual Property for Publicly Funded Research* (ICSTI, 2004) was drawn up. It was hoped to maximise the socio-economic benefits of publicly funded research in Ireland while still using knowledge created for the greatest public benefit. Following this, an agri-food-targeted document, *Policy on Intellectual Property*, was created and published by Teagasc in August 2007 (Teagasc, 2007). Against this background there have been continued government incentives to increase the commercial exploitation of publicly-funded research, but progress has arguably been slow. A recent study of food researchers in public institutions-funded food research in Ireland found that although there was a high-to-mid level of awareness of IP protection, in a significant number of projects it appeared that patents were not defined a project objective (Henchion *et al.*, 2008).

Over 200 projects have been funded to date through FIRM (Department of Agriculture Fisheries and Food, 2009). A breakdown of these projects is presented in table 3.4.

Table 3.4: Breakdown of FIRM projects funded between 2000 and 2010

Topic	Total Number of Projects	Examples of projects
Information gathering or dissemination	~ 30	Development of a national food consumption database Developing a technology commercialisation toolbox for publicly funded food research
Directly purchasing equipment	8	Developing the High Resolution Nuclear Magnetic Resonance Facility
Developing protocols for, and expertise in, using process technologies	~20	High pressure processing Ohmic heating and radio frequency
Frontier research	~15	Sourcing bioactives from plant, animal, and microbial tissues - Bioactives from meat - Bioactives from seaweed
Food safety and quality	>140	Rapid detection of antibiotic residues in milk using disposable bio-chip sensors Detection and risk assessment of *Toxoplasma gondii* in meat and meat products
Utilising food manufacturing by-products	~6	Potato peel utilisation

3.9.3.2 In-house research in the food industry

In addition to lower-than-EU average rates of publicly-funded R&D, food business expenditure on R&D is among the lowest of all industries (Forfás, 2007). Unlike other sectors, such as medical instruments and pharmaceuticals, investment has not increased significantly in the last decade (FAO, 2006). The low margin nature of the industry may be a contributing factor to this. A number of Irish-owned food and beverage multi-national corporations (MNCs) have established R&D functions in Ireland [*e.g.* Diageo (Dublin) and Glanbia (Kilkenny)]. However, these are the exceptions to the general rule. The reported low level of R&D investment may be attributed to the large proportion of food SMEs who may not have resources for, or a background in, R&D (Department of Agriculture Fisheries and Food, 2005). However, as noted previously, using R&D statistics as a measure of innovation intensity in the food industry is subject to criticism, in particular in relation to innovation in SMEs (Avermaete *et al.*, 2002; Kleinknecht *et al.*, 2002); it may underestimate the true level of activity. Therefore, a sector-specific innovation index, such as those being constructed by NESTA, may be of particular use in the food industry.

3.10 CONCLUSION

The definition of innovation has evolved significantly in the last hundred years. Due to its subjective nature the term is open to many different interpretations. This chapter discusses the varying interpretations of this complex multifaceted concept and outlines the approach taken to innovation for use in this research. Following this, a discussion of international and national innovation levels was also presented.

Chapter 4

Absorptive capacity

4.1 INTRODUCTION

This chapter presents a synthesis of the findings from the literature review of the area. The review was grounded in studies conducted in the food industry whenever possible. However, such studies were limited in number, and as a result, literature from other industries was also drawn on (*e.g.* biotechnology, electronics, pharmaceutical and printing). In doing so, it was anticipated that insights gained in other industries could reinforce and enhance the available knowledge of 'best practice' in the food industry.

4.2 TECHNOLOGICAL INNOVATION IN SMES

For a technological innovation to occur, both a source of an idea, an ability to assimilate the concept, and the skills to exploit the new knowledge for the company's benefit, are required (Todorova and Durisin, 2007). Ideas may be sourced internally or externally to the firm. However, a number of studies have postulated that SMEs are at a disadvantage in sourcing such ideas (see table 4.1).

Table 4.1: Challenges faced by SMEs striving to take on technological innovations

Disadvantage	***Authors***
Low levels of highly qualified human capital (*e.g.* scientific, engineering or management know-how)	Traill and Grunert, 1997; Fryer and Versteeg, 2008; Romijn and Albaladejo, 2002; Woerter and Roper, 2010
Difficulty accessing external finances, lack of internal finances for innovation	Traill and Grunert, 1997; Garcia Martinez and Briz, 2000; Woerter and Roper, 2010; Vieites *et al.*, 2011
Short term business view	Traill and Grunert, 1997
Insufficient information/uncertainty regarding legal regulations and market forces	Traill and Mullenberg, 2002; Cantillon *et al.*, 2005; Kühne *et al.*, 2010
Diseconomies of scale	Nooteboom, 1994; Karantininis *et al*, 2010
Lower levels of dedicated R&D resources, personnel and facilities	Shefer and Frenkel, 2005; Supnithadnaporn and Jung, 2007; O'Reilly and Henchion 2010; Vieites *et al.*, 2011

These difficulties are further compounded by the low margin nature of the food industry, which may make it difficult for companies to justify the channelling of investment into research, and the employment of high-level graduates necessary to achieve conduct such activities. As a result of these limitations, many companies are often restricted in their ability to generate ideas internally, and must utilise external sources (Batterink, 2009). Furthermore, the ability to assimilate and exploit the information, following the generation of an idea, may also be limited. External organisations, such as publicly-funded food research centres and third level institutes (TLIs), can have an influential role in addressing these failings by providing the knowledge and supports required to innovate (Batterick, 2009). However, Menrad (2004) suggested that the limited capacity of food SMEs to absorb and integrate external knowledge into current activities was restricting the potential benefits from publicly-funded food research. This creates a cyclical paradox in which low levels of absorptive capacity both impede and necessitate the use of external resources to innovate.

The literature on absorptive capacity provides valuable insight into the process of taking on information (such as a technological innovation) from a source external to the company. However, a number of other theoretical frames could also be used to further understand this process, for example: technology transfer models; open innovation paradigm; and the diffusion of innovation literature.

The definition of technology transfer has been found to differ widely depending on the discipline involved (Henchion *et al., in press*). However, it is generally accepted to involve all stages and influencing factors involved in the transfer of research from public research organisations to a commercial environment (ICSTI, 2004). The literature provides useful insights into this process including; its multi-disciplinary nature (Rogers *et al.,* 2001); the value of developing sustained relationships between parties involved (Feller *et al.,* 1987), the importance of goal-oriented research (Autio and Laamanen, 1996); and the relevance of commercialisation to qualify success of the transfer process (Power and McDougall, 2005). However, the technology transfer literature is over arching in nature and as this research was attempting to understand the point of view of company, the absorptive capacity literature was thought to be a more relevant theoretical lens.

As discussed in the previous chapter, Chesbrough's (2003) *open innovation paradigm* is similar in nature to the concept of absorptive capacity. However, Traitler *et al.* (2011) exhorted that open innovation had become "an overexploited buzzword", with each company interpreting the term differently. Trott and Hartman, (2010) advised caution when applying this 'new paradigm' due to its similarities with previous work (see section 3.3) (Allen, 1969; Tilton 1971; Mowery, 1983; Rothwell and Zegveld, 1985; Cohen and Levinthal, 1990). Following Sarkar and Costa's (2008) application of this 'paradigm' to the food industry, they advocated improving company technological and marketing capacities to enhance returns from innovation activities. Such conclusions could also have been drawn from application of absorptive capacity literature. As Spithoven *et al.* (2010) pointed out; absorptive capacity is in fact a prerequisite for involvement in open innovation activities. Indeed, by predicating open innovation, absorptive capacity is of paramount importance. As a result, the original concept of absorptive capacity was favoured as the focal point of this study.

The theory of 'diffusion of innovation' (DOI), developed by Rogers and Shoemaker (1971), is arguably an alternative way of looking at the process of absorptive capacity. Originally this concept was used to describe the way in which a novel idea spreads among members of a particular social system (*e.g.* the food industry). Rogers (2003) proposed that five elements influenced the diffusion of innovation (see table 4.2).

Table 4.2: The five elements that influence the diffusion of innovation (as defined by Rogers)

Relative advantage:	
	the degree to which an innovation is perceived as being better than the idea it supersedes
Compatibility:	
	the degree to which an innovation is perceived as being consistent with existing values, past experiences and needs of the receivers
Complexity:	
	the degree to which an innovation is perceived to be difficult to understand
Trialability:	
	the degree to which an innovation may be experimented with on a basic level
Observability:	
	the degree to which the results of an innovation are visible to others

Source: Rogers (2003:138-155)

By assessing the *relative advantage* of a technological innovation, a company can improve the initial valuation step of the absorptive capacity process. Advantage can infer both economic and more indirect benefits to company performance (Denis *et al.*, 2002). A number of financial methods for evaluating the economic advantage of a technology are related in the literature [*e.g.* payback; return on investment; discounted cash flow measures of net present value; and trade-in values for old machines (Shank, 1996; Abdel-Kader and Dugdale, 1998)]. In contrast, advantages that have a more indirect effect on firm performance may include allowances for the following: increased flexibility, lower inventory levels, increased quality, increased environmental friendliness, social benefits, time saved and hazards avoided (Tornatzky and Klein, 1982; Beaumont, 1998; Flett *et al*, 2004). Unsurprisingly, Flett *et al.* (2004) found that most credence was given to the economic objectives of increased production and profit. However, it has been found that placing a premium on short-term financial results, as opposed to the more-difficult-to-quantify benefits, has prevented major manufacturing breakthroughs (Shank, 1996; Morgan and Daniels, 2001). Morgan and Daniels (2001) asserted that regardless of the sophistication of the evaluation method used, disruptive technologies always faired worse in cost analysis due to the high costs involved and the difficulty in assessing future returns on investment. This would be to the detriment of more radical innovations, which require longer development timelines and more extensive investment (*e.g*. there was a 16 year gap between invention and commercialisation of Benecol™, the cholesterol-lowering spread developed by Vallio; however, the return on the investment has been considerable).

In terms of technology *complexity*, it has been found that the harder it is to understand and use the technology, the slower the rate of adoption (Haider and Kreps, 2004; Rogers, 2005; Tornatzky and Klein, 1982). This has significant implications for publicly-funded research organisations endeavouring to transfer research to industry. It is important that the complexities of a technology are explained in order to facilitate adoption. Furthermore, this contributes in some way to explaining the popularity of incremental innovations over radical innovations due to the higher complexity of the latter (*e.g.* the replacement of Pasteurisation with high intensity light processing may be delayed by the complexity of the new process, whereas the extension of a line to include a modified flavour of sauce may be more readily accepted). Likewise, the *observability* of innovations may have an impact on how readily they are accepted. Highly visible impact from the introduction of a new technology has been found to be positively correlated to increasing adoption rates and lower rates of technology rejection (*e.g.* visible results such as the reduction in the oxidative browning of raw meat due to the adoption of novel packaging techniques has resulted in less rejection by consumers, reduction of waste and increased sales) (Denis, *et al.*, 2002; Øvretveit *et al.*, 2002; Tornatzky and Klein, 1982). However, it is important to make allowances for the target market of the visible benefit (*i.e.* the food producer, manufacturer or consumer). A genetically modified (GM) crop may result in increased economic returns for a producer; however, a lack of visible benefit to the consumer may inhibit uptake further downstream. Following this, *trialling* the success of an innovation can reduce perceived risk and increase rates of technology adoption [*e.g.* in pilot plant facilities such as the high pressure processing (HPP) rig in Teagasc Food Research, Ashtown and Queen's University Belfast, and the dairy pilot processing plant in Moorepark Technology Limited (MLT)] (Greenhalgh *et al.*, 2004; Rogers, 2003). O'Reilly and Henchion (2010:16) found that "accessibility of a scale-up plant" was a critical factor in the success of technology transfer activities between researchers and food companies. Pilot plant facilities provide the opportunity to run processing trials on current products to ascertain the outcomes of novel processes on the current portfolio (*e.g.* facilitating the assessment of sensory implications and shelf life tests) and also develop new products.

In this way, direct product testing and market research can be conducted, which enables companies to make a more informed cost benefit analysis. Although, this has been reportedly successful in MTL in terms of facilitating new product development in the dairy industry (which has a customer base of over 120 companies; RELAY, 2004), Irish industry appears to remain reticent regarding uptake of HPP despite considerable resource investment from the government.

The integration of external knowledge can also be said to be influenced by the final Rogerian factor, *compatibility*; high levels of compatibility are linked with increased levels of adoption (Greenhalgh *et al.,* 2004; Haider and Kreps, 2004; Rogers, 2003). Tornatzky and Klein (1982) believed that innovations needed to be firstly reconciled with the cognitive patterns of potential adopters (*i.e*. what people think or feel about a new technology). In relation to food technologies, this may be of particular importance, as potential adopters may feel the novel technology is not compatible with their personal norms and value set (*e.g.* personal opposition to GM crops, irradiation or cloning). This highlights the need to engage with industry to ascertain their opinion on such technologies, as objections to technologies may be more deeply rooted than pure economic assessment. Additionally, the more pragmatic form of compatibility (*i.e.* alignment with current operational practices) has potentially significant implications for the uptake of radical innovations, in which the level of compatibility to current practice could be low (*e.g.* in the case of a company which has primarily dealt with ambient products, the introduction of a frozen food range would be incompatible with the existing distribution mechanisms).

A considerable proportion of the DOI studies were carried out in the field of healthcare (Denis, *et al.,* 2002; Øvretveit *et al,* 2002; Greenhalgh *et al.,* 2004), in which improvement in practice can be seen as the ultimate goal. Therefore, innovations that have been shown to be effective in other clinical settings are routinely adopted. Conversely in industry, companies are often motivated by a desire to offer something different from their peers (*i.e.* to improve competitive advantage) (Fryer and Versteeg, 2008). However, this observation may be limited to more radical innovations. Due to the prevalence of 'of 'me-too' innovations in the food industry (Ernst and Young, 1999), examination of the DOI literature can enrich and enhance the understanding of factors influencing technological innovation in industry (Haider and Kreps, 2004; Wonglimpiyarat and Yuberk, 2005; Uddin, 2006). Indeed, the constructs proposed by Rogers to illustrate the DOI concept can provide a useful insight into the absorptive capacity process.

4.3 Absorptive capacity – The formalisation of a concept over twenty years

The following sections review the literature surrounding absorptive capacity. The term *absorptive capacity* was coined by Cohen and Levinthal (1989, 1990, and 1994) in their three influential papers. Building on previous related literature, Cohen and Levinthal (1990:128) defined absorptive capacity as a firm's ability to "recognise the value of new, external information, assimilate it, and apply it to commercial ends". Although several authors had made reference to the concept of absorptive capacity prior to Cohen and Levinthal, the paper in 1990 is seen as a seminal contribution to the literature (Zahra and George, 2002; Lane *et al.,* 2006; Todorova and Durisin, 2007; Fosfuri and Tribo, 2008). In an era of an "abundant underlying knowledge landscape" (Chesbrough *et al.,* 2008:11), the concept of absorptive capacity aims to explain why some firms benefit from available knowledge to a greater degree than others. If the external information is potentially available to all companies, some contribution to successful absorption must arise from the characteristics and actions internal to individual firms (Fabrizio, 2009). This has been shown by Woerter and Roper (2010), in a study of Irish and Swiss firms; they found that firm-level capabilities (such as innovation strategies, in-house R&D and the ability to source external knowledge) largely determined innovation performance, as opposed to market demand conditions. This was true for both the occurrence of product and process innovation and the level of commercial success of innovations (measured as percentage sales from innovative products). Drawing on this, measures which support the capacity of a company to innovate were thought to improve the translation of knowledge into commercial return, regardless of market conditions.

A key premise of the absorptive capacity process is the initial investment required to develop a knowledge base so that the company may incisively discriminate between the profusion of available information resources (Cohen and Levinthal, 1990). While it is vital for SMEs to look externally to the firm for potential innovations, it is also imperative to be able to discern specific value to the company, before committing scarce resources to their development. Cohen and Levinthal (1990) proposed that the cessation or avoidance of R&D activities would result in an inability to assimilate and exploit new information. Indeed, the importance of R&D cannot be underestimated, as was shown in recent studies discussing the role played by R&D in facilitating the uptake of external knowledge and reducing the uncertainty regarding development timelines and expense of innovating (Romijn and Albaladejo, 2002; Fabrizio, 2009; Bishop *et al.*, 2010; Schmidt, 2010; Camisón and Forés, 2011; Song *et al.*, 2011;). Fabrizio (2009) and Camisón and Forés (2011) believed that firms must reach an internal critical mass of knowledge in order to develop their level of absorptive capacity. Without this critical mass, companies would be limited in their ability to recognise the potential from external knowledge and to generate value for the company from investing in the knowledge. Therefore, in order to facilitate assimilation, the new knowledge must be similar in part to prior knowledge within the company (*i.e.* path dependent). However, to glean benefit from the new knowledge, there must be some divergence from what is known already in the company (figure 4.1).

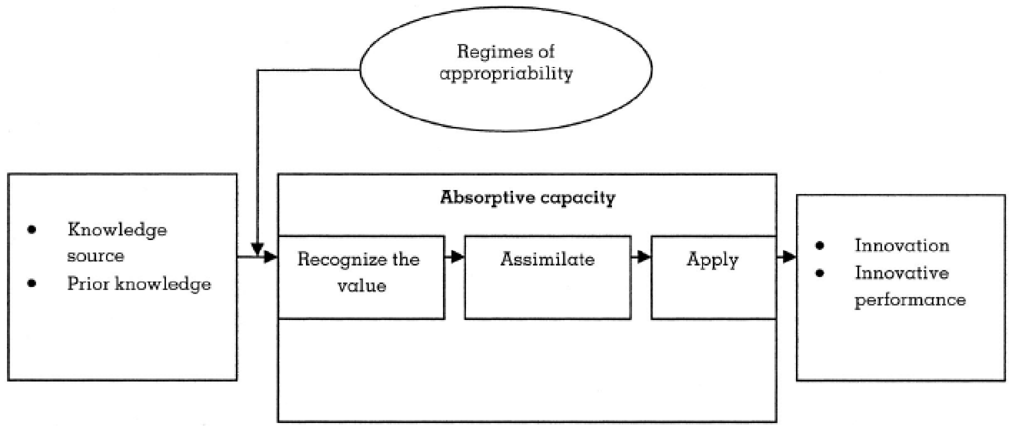


Figure 4.1 An illustration of the model of absorptive capacity proposed by Cohen and Levinthal (1990) (Source: Todorova and Durinsin, 2007) *(Regimes of appropriability are discussed in section 4.5.2.1)*

Arguably the focus on the path-dependent nature of knowledge acquisition does not account for the common practice of acquiring such knowledge through the services of a consultant or the take-over of a company with the required set of knowledge (*i.e.* Kraft's 2010 take-over of Cadburys in order to develop its chocolate portfolio and related knowledge, Nestlé's take-over of Findus in 1962 to avail of their frozen food expertise). However, for a company to comprehend the input of a consultant and enable the uptake of advice, a certain level of prior understanding must be present within the company. Furthermore, due to the low margin, SME, nature of the food industry, the option of company acquisition is limited to the larger players and not of relevance to the majority of Irish companies.

In the original description of the concept, Cohen and Levinthal (1990) outlined a process based on value recognition, technology assimilation and eventual translation into commercial return. The emphasis on investment into R&D, inherent in the original paper, is thought to have led to many subsequent studies equating R&D investment with absorptive capacity (Mowery *et al.* 1996; Tsai, 2001; Lane *et al.*, 2006). This interpretation has lessened the impact of the research, as it did not capture all the contributing factors to the capacity in companies (*e.g.* structures, policies, human capital investment).

Following this criticism, the concept of absorptive capacity continued to evolve from being a static, narrow, R&D focused process, to a recognition that it is a dynamic set of knowledge-based capabilities with many influencing factors (Zahra and George, 2002; Todorova and Durisin, 2007). Zahra and George (2002:198) highlighted the dynamic nature of absorptive capacity, by defining it as a "set of knowledge-based capabilities embedded within the firm's routines and strategic processes". The authors divided absorptive capacity into two subsets: potential (acquisition and assimilation) and realised (transformation and exploitation), with a ratio of the two subsets used to derive an absorptive capacity efficiency factor. This ratio was deemed to represent the ability of a firm to leverage the knowledge absorbed. However, as noted previously in SMEs, a strategic decision could have been made by a company not to pursue commercialisation of certain knowledge, which would not be accounted for by this ratio. Todorova and Durisin (2007) further criticised this interpretation of the concept, proposing that assimilation[4] and transformation were in fact alternative processes. They proposed that the option favoured by the company depended on the degree of difference between present and new knowledge, with a large difference necessitating transformation as opposed to assimilation into current practices. Todorova and Durisin

[4] Todorova and Durisin (2007) described how when new information was similar to that already in the company, the existing cognitive structures did not have to change and the knowledge is *assimilated*. In contrast, knowledge that is incompatible with current cognitive frames of reference involve transformation of the information within the company, before it can be integrated into company practice.

(2007) further criticised the Zahra and George (2002) model for omitting the concept of recognising the value of external knowledge, and for suggesting that the influence of social relationships was limited to the assimilation of knowledge. In contrast, Todorova and Durisin (2007) believed that social relationships internal to the firm affected the whole absorptive capacity process, with particular focus on the role of power relationships as an antecedent to absorptive capacity. At the heart of this premise is the ability of company strategies and policies to facilitate ease of communication between companies and knowledge providers; these issues, and their application to the food industry, will be discussed in detail in section4.6.

4.4 STARTING POINT FOR INVESTIGATING TECHNOLOGICAL INNOVATION

Based on a comprehensive review of the literature, Lane and colleagues (2006) proposed a broad model, which framed the process of absorptive capacity within the realities of the business environment (figure 4.2). By examining the process in the wider context, more meaningful interpretation of results are possible (Fosfuri and Tribo 2006; Mowery *et al*., 1996; Szulanski, 1996). In doing so, “the role of the firm’s environment in determining the incentives for investing in absorptive capacity” can be investigated (Lane *et al.*, 2006:857). Based on a review of the literature, it was decided that the Lane *et al.* (2006) model of absorptive capacity was an appropriate frame for examining a firm’s decision to invest in technological innovation. As shown in the figure, the external, and dyadic, factors (which link the external environment to the process of absorptive capacity), are depicted to the left of the figure; above and below the centre are influences internal to the company, and to the right are outcomes of absorptive capacity. Each of these factors will be dealt with in the following discussion.

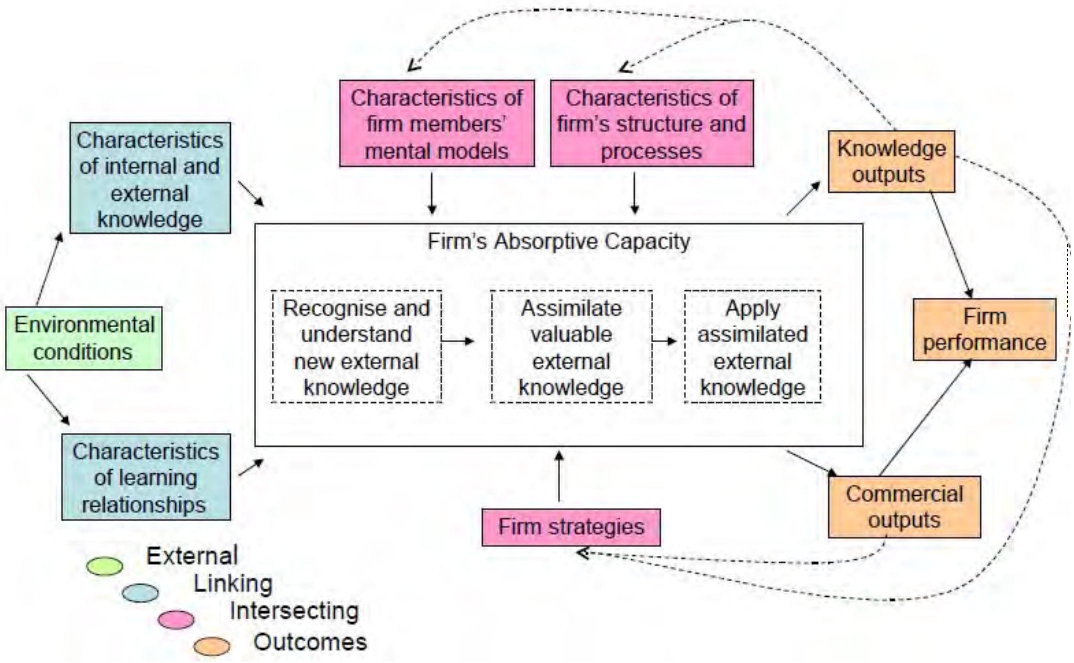


Figure 4.2: A Model of absorptive capacity based on Lane et al. (2006)

4.5 External factors influencing technological innovation

A number of studies have reinforced Cohen and Levinthal's (1990) position that all innovation occurs through the filter of the external environment (Fosfuri and Tribo 2006; Lane *et al.* 2006; Mowery *et al*. 1996; Szulanski, 1996). Lane *et al.* (2006) suggested investigating the industry, regulatory and knowledge environment in order to ascertain the incentives for developing company absorptive capacity. However, the economic environment also presents a set of challenges to those engaging in technological innovation. The latest figures available show 2009 to have been a very difficult year for both Irish (sales decreased 13 percent on the previous year) and foreign-owned (sales decreased by 7 percent in the same period) companies. Manufacturing companies suffered the largest reduction in sales, with Irish-owned manufacturers reporting a 15 percent decline. This has particular implications for the food industry, the majority of which are indigenously owned manufacturing companies.

4.5.1 Industry/operating environment

The challenges facing the highly competitive, export orientated, Irish food industry were outlined in the previous chapter. In Porter's (1985) Five Competitive Forces model, he postulated that industry structure determined the degree to which factors such as suppliers, potential entrants, buyers, substitutes and industry competitors' impact on a firm's ability to be sustainable. If a firm perceives extensive pressure from these factors, it may be driven to innovate in order to increase its competitive advantage. For example, in the last two decades there has been a rise in own-label market share, with products competing in terms of quality, packaging and technology with the leading brands (Garcia Martinez and Briz, 2000; Leyland, 2009). Such products form a major competitive threat for branded food manufacturers. Alternatively, from an SME perspective, own-label products can also provide opportunities to maximise the efficiency of production plants by utilising "down-time" on machines for the manufacture of these products. High level of 'me-too' products are evident in the food industry (Ernst and Young, 1999), which increase competition for shelf space. In order to prevent 'me-too' or own label products encroaching on company market-share, a strategy available to companies is to enhance product differentiation through more radically innovative products which offer consumer-relevant advantage (Garcia Martinez and Briz, 2000; Trail and Grunert, 1997). Unfortunately, the outcomes from investing in innovation cannot be predicted accurately, and this creates great uncertainty for companies, particularly for those working within tight margins (Tepic *et al.*, 2009). However, relying solely on existing products favours the players with the lowest cost base, because 'me-too' products continue to emerge and competition becomes increasingly centred on cost (FAO, 2006). Despite improvements in recent months, Ireland's cost base remains high following a period of high domestic inflation, and creates a challenging environment for companies operating here (National Competitiveness Council, 2010). Operating costs may drive innovation in order to reduce this outlay. However, the cost of innovating has been found to be a significant barrier to the majority of firms in two recent surveys of Irish companies (Forfás, 2008; Henchion *et al., in press A*). This is not limited to Ireland, however, as similar results were also found in other European countries (Garcia Martinez and Briz, 2000; Vieites *et al.* 2011). A complex relationship thus develops in which the industry environment both constrains and drives innovation in firms.

4.5.2 Regulatory environment

The regulatory environment has a particular bearing on the occurrence of innovation in food companies as it can either restrict or stimulate innovation depending on the focus of the regulation. The majority of food law in Ireland derives from our membership of the European Union (FSAI, 2011). It has been found that for those operating in the food industry, the regulations of highest perceived importance related to food safety and quality issues (Cantillon *et al.*, 2005; Massoud *et al.*, 2010). While the costs of complying with food safety standards are thought to be quite high for SMEs (Cantillon *et al.*, 2005), Fryer and Versteeg (2008) were of the opinion that food safety alone was rarely a sufficiently strong driver for innovation that would be of economic benefit for the company. Food companies must implement change within the firm to achieve such standards, and the limited available internal funds have to be directed towards achieving this, as opposed to innovations with the potential for economic return for the company (*e.g.* training expenditure directed towards food safety as opposed to market orientation or new product development).

Additionally, the restrictive nature of European food legislation [such as the Nutrition and Health Claims (1924/2006/EC) and Novel Foods and Novel Ingredients (258/97/EC)] has often been blamed for the lesser development of food innovations (such as functional foods) compared to in the US and Japan (Bech-Larsen and Scholderer, 2007). Furthermore, Coppens *et al.* (2006) acknowledged that the numerous pieces of legislation and accompanying procedures make the process of achieving market readiness both costly and time consuming.

4.5.2.1 The precautionary principle

The 'precautionary principle' first emerged in Sweden and Germany in the 1960s. It has since become enshrined into international treaties and declarations [*e.g.* The 2000 Cartagena Protocol on Biosafety (Turvey and Mojduszka, 2005); the 2008 Stockholm Treaty on Persistent Organic Pollutants (Stockholm Convention, 2008)]. In 2000 the EC outlined the following criteria for use of the principle:

> *The precautionary principle applies where scientific evidence is insufficient, inconclusive or uncertain and preliminary scientific evaluation indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen by the EU. (European Commission, 2000)*

Since 2000, the principle has come to inform much EU policy, particularly EU food law (Fisher *et al*, 2006). Following this shift in thinking, Stevenson and Williams (2002:39) asserted that "an uneasy mix of science, politics and economics now pervaded" the agribusiness value chain. The Novel Foods and Novel Ingredients EC (No.) 258/97 regulation is an example of a food law based on this principle. This regulation has significant impact on innovation occurring in the EU and in countries importing into the EU. Any foodstuffs not consumed to a significant degree in the EU prior to May 1997 have to undergo rigorous, extensive testing before being accepted as safe for human consumption (for a more detailed description of the EC 258/97 see Appendix I). Although created in order to protect consumers, it has been argued that the widespread enforcement of this principle inhibits innovation by creating insurmountable barriers for innovating companies (Goldstein and Carruth, 2005; Hermann, 2009). The validity of the regulation has been called into question over a debate regarding the allowance of cloned animals and their offspring into the food chain (Coakley, 2011). Due to an inability of the European Council and the European Parliament to find a compromise on this issue, the revision of the legislation will not proceed as planned. As a result, new food innovations, such as nanomaterials, remain unlegislated for at present (Coakley, 2011). This creates great uncertainty for food companies hoping to innovate in these areas.

Further to this, the Nutrition and Health Claims (1924/2006/EC) legislation was adopted in December 2006. Integral to this regulation is the establishment of an authorised (restricted) list of nutrition and health claims which food producers may use on their product advertising literature (Binns, 2008). Jones and Jew (2007:389) asserted that "the restrictive health claim environment has resulted in substantial challenges in terms of communication of food/health relationships to the general public". This regulation continues to advance with opinions on submitted claims published every few months (for the period August 2008 - June 2011). The evolving nature of this law, and other legislation based on the precautionary principle, has created great uncertainty for food and biotechnology companies (McNeil and Williams, 2002). However, the need to comply with evolving legislation may also be inspiring and driving innovation in many companies, although the cost implications may mean such innovations are beyond the scope of many SMEs. In order to ensure that companies are sufficiently able to address the constantly evolving legislative environment, it is imperative that a level of absorptive capacity is established within each company. By doing so, such companies can recognise the application of legislation to their business and open possibilities for exploiting it.

4.5.2.2 Intellectual property

IP is the unique, original creative output of human intellect and can have marketplace value (Forfás, 2004). IP can take on many forms, spanning patents, trademarks, registered designs and licences. IP is used as a means of protecting technological innovations within companies. The development, commercialisation and exploitation of IP can create significant revenue for a company (Forfás, 2004). Results from Kitching and Blackburn's (1998:330) study of IP protection in UK SMEs found that the top methods of protecting "specialist or codified knowledge" were non-registered rights, with three quarters of the sample indicating their use [*i.e.* confidentiality clauses in employee contracts (76%) and in customer and supplier contracts (75%)]. The formal types of innovation protection were not used as broadly, with trade or service marks (52%) exceeding the other forms [*i.e*. registered design (31%) and patents (30%)]. The high level of trade and service marks evident may be reflective of the nature of the study cohort, which was made up of computer service, design, electronic and mechanical engineering SMEs. In terms of relative usage of IP protection mechanisms among a sample of European biotechnology companies, non-disclosure agreements (~71% of respondents) and patents (~69% of respondents) were found to be the most favoured (Stevenson and Williams, 2002). However, it is unlikely that this level of IP usage prevails in food manufactures due to their low tech and low margin nature (Menrad, 2004).

When discussing their model of absorptive capacity, Cohen and Levinthal (1990) referred to the importance of appropiability regimes (*i.e.* the degree of value captured, and information spill-over from innovation activity). Based on empirical research, Cohen and Levinthal (1990) proposed that high levels of spill-overs between competing companies (and therefore a weak appropiability regime) actually encourage research intensity. They found that this was particularly true for industries in which the difficulty of learning was greater (*i.e.* applied sciences as opposed to basic science, as in the food industry). A recent study by Camisón and Forés (2011:80) agreed with this premise, and stated that “the richer a district is in knowledge spill-overs, the greater the benefit firms obtain”. Zahra and George (2002), in contrast, believed that the incentive to invest in R&D was not as strong in markets with a low efficacy of IP protection, as competitors are more likely to accrue substantial returns. The level of uncertainty surrounding the appropiability of the results from joint ventures is thought to be affecting the success of collaborations between industry and universities in the UK (Frenz and Ietto-Gillies, 2009).

Ireland, as demonstrated by the European Innovation Scoreboard, is below the European average in terms of formal IP usage. This may be due to a lack of knowledge of the supports available for applications (*e.g.* Enterprise Ireland Intellectual Property Unit and Tech Transfer Service). However, traditionally within the research sector, performance measures did not focus on technology transfer to industry or securing IP protection, but rather on publication in peer reviewed journals (O’Reilly and Henchion, 2010). As efforts to commercialise research activities were not central to the role of the researcher/lecturer, a situation of slow decision making and reactive behaviour was thought to prevail (Williams, 2002). Indecision and a lack of guidance relating to the university policy of IP protection was found to be contributing to this situation

(O’Reilly *et al.*, 2010). Nevertheless, it has been found that this attitude is changing, with increased emphasis being placed on commercial success of publicly-funded research (O’Reilly and Henchion, 2010). This may be attributed in part to the increased emphasis placed on IP protection in the *National Code of Practice for Managing Intellectual Property for Publicly Funded Research* (ICSTI, 2004) and within FIRM projects in the *Policy on Intellectual Property* (Teagasc, 2007).

Looking specifically at the issues facing those hoping to secure and maintain a patent, it has been acknowledged that this is a convoluted and expensive process (Kessler and Bierly, 2002). In addition, the cost of prosecuting violators is extensive. Another issue faced by food companies trying to patent is the length of time required if hampered by regulatory issues (*i.e.* slowing time to market and thus interfering with competitive advantage) (Kessler and Bierly, 2002). These challenges are particularly pertinent in the low margin food industry, in which products can have extremely short life-cycles (*e.g.* six months) and may not provide sufficient scope to recoup an extensive investment in development.

4.5.3 Knowledge environment

Included in the Lane *et al*. (2006) model was the concept that the knowledge environment impacts on innovation occurring in companies. They (2006:857) define the knowledge environment as “the knowledge produced by corporate and non-corporate sources”. A number of studies have suggested that information from commercial bodies (*e.g.* suppliers, customers or competitors) is critical for successful innovation (Avermaete *et al*., 2004; Rabson and Haigh, 2008). Stewart-Knox *et al*. (2003) found that the input of retailers resulted in the development of more successful products, and suggested that this may be due to the retailer’s superior market knowledge. However, the constraints imposed by retailers (in terms of profit margins, product specifications and time-scales) placed a large amount of pressure on manufacturers. This retailer-driven pressure was also highlighted by the Irish Food and Drink Industry representative group (FDII), which attributed the level of power held by retailers to the high levels of concentration in the grocery retail sector. This was thought to result in a significant asymmetry in bargaining power which favoured the retailers, and as a result food manufacturers were under significant pressure to meet demanding conditions of sale in order to ensure access to market (FDII, 2009). This situation was thought to be driving innovation from a company perspective, as SMEs strove to engage with the larger retailers and maintain market share and shelf space.

Conversely, the acceleration effect of publicly-funded research in stimulating privately-funded research has also been demonstrated (Salter and Martin, 2001). Developing collaborations with research institutions is regarded as crucial for more radical innovations, particularly in small low-tech firms, as the in-house means to conduct research and the necessary know-how may be lacking (Avermaete *et al.*, 2004). Fabrizio (2009) concurred with this opinion, stating that collaborations with university scientists improved both the pace of innovation and the quality of the resultant innovations. Furthermore, Stewart-Knox and Mitchell (2003) found that communications with agencies (*e.g.* local or national research organisations) enhanced innovation success in food companies. Bishop *et al.* (2010) provided empirical evidence that companies perceived significant benefits from associating with TLIs; improvements in fundamental understanding (*e.g.* access to new ideas from basic research) vied with problem-solving assistance (*e.g.* support with market introductions of new products), in terms of the most valued benefit from such associations. Companies which had sufficiently developed absorptive capacity to engage with TLIs benefited in terms of resultant innovations that arose from such collaborations. A component of beneficial problem-solving assistance was attributed to close geographical proximity to the TLI of interest. However, it is important to note that this work only included a small proportion of food companies and the sample was primarily sourced from the chemical and electronic industries. Nonetheless, the importance of publicly-funded research in the Irish food industry was highlighted by the Teagasc 'Toolbox Project', which examined the research commercialisation and technology transfer process of publicly-funded food research in Ireland (Henchion *et al., in press* A). Larger, high-tech food companies are also believed to benefit from this type of open innovation (Chesbrough, *et al.*, 2008; Sakar and Costa, 2008).

4.5.3.1 Economic Clusters

An expansion of the belief that a developed knowledge environment benefits companies is the concept of 'geographic clusters' (Lane and Lubatkin, 1998). Clusters are defined as:

> *Geographic concentrations of interconnected companies, specialist suppliers, service providers, firms in related industries and associated institutions, in particular fields that compete but also co-operate* (Porter, 2000:15)

Clusters can include both corporate and non-corporate entities. Successful technology clusters include 'Medicon Valley' of Denmark, 'Silicon Valley' in the US, and the German and Swiss 'Mittelstand' in Southern Germany and Zurich (Tovstiga *et al*. 2007). Based on Porter's theories, clusters may provide an effective way of promoting food innovations. For example, in the 1950's, frozen foods were seen as a 'really new' technology in Sweden, however, Beckeman and Skjoldebrand (2007) hypothesised that it was a cluster of frozen food producers and supporting industries in the South of Sweden that ensured the smooth acceptance of this technology by Swedes. In this, a “bottom-up” collaboration of a number of actors (frozen food producers, distributors, and refrigeration technology suppliers) across the supply chain formed the *Frozen Food Institute*. This organisation co-ordinated the activities of the players involved and managed interactions with the public, the trade, and producers all over the country. In addition, the first CEO was linked strongly with the “government circle”, and this was felt to contribute to the speed of the passing of regulations, which ensured quality of the products produced and contributed to a positive image of the frozen foods (Beckeman and Skjoldebrand, 2007:1420). However, this cluster has dissolved following the establishment of frozen foods in the market place and has not been updated to facilitate the uptake of more recent technological advances. Beckeman and Skjoldebrand (2007) attribute this, in part, to the shift in power from manufacturers to retailers, and believed that the onus was now on retailers to take the lead in encouraging the development of more radical innovations. This growing retailer power has been discussed in section 4.5.3. Due to the importance of retailers in future innovation, and the probability that they will not be found in one geographic area, the concept of clusters may have limited applicability in the food industry in coming years.

In Ireland regional food clusters have developed in some regions, such as Naas, and in certain sectors, such as food ingredients and infant nutrition, with three of the world leaders established in the country (Abbott, Wyeth and Numico). A report looking at industry clusters in Irish indigenous manufacturing acknowledged that although it was possible that the clusters contained the connections and relationships characteristic of Porter’s industry clusters, they were not being optimised due to the limited scope of the machinery, specialty inputs and service industries related to this grouping (O’Malley and Van Egeratt, 2000). However, the authors felt that “relatively good competitive performance and quite strong growth have been possible for many sectors which are not part of discernible indigenous Porter-style clusters" (p 75). They attributed this to the small size of Ireland and the high quality infrastructure in place. As a result of this, the authors suggested that formalised clusters, as described by Porter, may have limited application in the Irish setting.

Furthermore, Foss (1999) originally pointed out that highly developed firm capabilities facilitated the accruement of benefits from networks. Progressing this, Camisón and Forés (2011) found that absorptive capacity was necessary to garner benefit from clusters, and that developing network capabilities and absorptive capacity were complementary processes. Therefore, the investigation of the elements which contribute to absorptive capacity development, as opposed to clusters, is appropriate.

4.5.4 Economic environment

Although not included specifically in the Lane *et al*. (2006) model, the impact of the economic environment and the resultant availability of finance are also important considerations for those engaging in technological innovation. The restraint on consumer spending, arsing from the world-wide recession, has created a challenging environment for food companies (Bord Bia, 2009). This has prompted a reduction in domestic and export sales and changes in the market conditions (*e.g.* the further rise in market penetration of own-label products) (Leyland, 2009). The repercussions of limited credit availability have been felt across the manufacturing sector, and the food industry is no exception (Bord Bia, 2008). In two recent surveys of companies in Ireland, the lack of available external financing was seen as a significant barrier to innovation activities (Kelly *et al.*, 2008; Forfás, 2011). Funding by the Irish government for innovation efforts has opened avenues to innovation (*e.g*. Enterprise Ireland's

Innovation Vouchers and Innovation Partnerships[5]). However, there is potential for greater uptake of these supports. This may be attributed to a lack of awareness of the available supports or the perception of high levels of complexity involved in the application process. Furthermore, the high costs of establishing and staffing R&D facilities, and maintaining a high level of research, can be seen by many companies as insurmountable, particularly for SMEs.

4.6 INTERNAL DRIVERS OF ABSORPTIVE CAPACITY

A number of internal factors play a role in the development of absorptive capacity in a firm.

4.6.1 Characteristics of firms' members' mental models

4.6.1.1 Human Capital

Cohen and Levinthal (1990) attribute a component of absorptive capacity to the level of human capital, or the stock of knowledge and training (Wagner *et al*., 2003) present within a company. Koc (2007) found that the capacity to innovate was positively affected by the depth and variety of employee technical and analytical skills and experience. Post-school qualifications also contribute to technical, communication and social skills, and in turn, to improving innovation capability (Avermaete *et al.*, 2004; Freel, 2005; Woerter and Roper, 2010). A number of studies have found that innovation was more frequent in companies with higher incidences of qualified scientists and engineers (QSEs) (Koc, 2007; Romijn and Albaladejo, 2002; Stendal and Roos, 2008). However, Freel (2003) found that it was the employment of technicians, not QSEs, which positively affected the success of innovation in a company. Stewart-

[5] Enterprise Ireland provides a number of grants companies engaging in innovation, details of which can be found at: www.enterprise-ireland.com/en/Research-Innovation/.../R-D-Funding/

Knox *et al.* (2003) concurred with this opinion, having found that the presence of a food technologist on a NPD team greatly enhanced product outcomes (particularly in terms of idea generation, recipe formulation and scale-up). However, this may be associated with to the specific type of innovation occurring. Indeed, Huiban and Bouhsina (1998) found that different levels of skill facilitated different types of innovation, with the radical product innovations benefiting from high levels of technical and scientific knowledge, whereas incremental process innovations required a level of knowledge with regard to the firms operation (*e.g.* technicians or food technologist). Woerter and Roper (2010) found higher levels of product innovation in companies employing graduates. However, this did not translate to process innovations, in which graduate employment actually had a negative effect on the probability of such innovations taking place. The authors attributed this interesting finding to the possibility of process orientated firms being more likely to employ a larger unskilled workforce. In addition, Stewart-Knox and Mitchell (2003) pointed to the role of marketing capabilities in a company, which have particular importance in terms of idea generation and commercialising innovations. Sarker and Costa (2008), on reviewing open innovation practices in food companies, by improving both technological and marketing capabilities, a company could enhance innovation outcomes. The range of skills required can be attributed to the multidimensionality of innovation, with the nature of innovation desired begetting the type of qualifications required.

4.6.1.2 Education and training

Koc (2007) suggested that an inability to recruit high-quality technical staff could constrain growth of companies. This assertion was supported by an Irish survey which found that 11% of manufacturing industry and 9% of service firms identified ‘lack of qualified[6] personnel' as a factor hampering innovation activities (Forfás, 2008). Freel (2004:770) agreed with this opinion, stating:

> *The presence of education and training systems which ensured a flow of individuals [into industry] with the requisite knowledge and skills, was a distinguishing feature of those countries that were able to beget and sustain competitive and innovative firms.*

A number of gaps in the available education and training programmes were noted, particularly in terms of business acumen and commercial awareness (sales and negotiation; packaging; incremental product development; logistics; supply chain management and lean manufacturing). Therefore, the importance of "well-rounded" graduates, versed in both advanced technical and business acumen skills, was evident. Nonetheless, the ability of the low margin food industry to attract such graduates is debatable.

Controversy surrounds the importance of training for staff in the literature. Romijn and Albaladejo (2002) claimed that training did not always translate into higher innovative capability if the focus of training is on improving managerial or secretarial functions within the firm, not on innovation. This is in contrast to findings of a UK and European study where it was found that the most innovative firms train more staff and invest more in staff training (Avermaete *et al.*, 2004). Furthermore, the most innovative firms were found to be engaged in training, not only in the mandatory area of health and safety, but also in technology training and training in IT (Avermaete *et al.*, 2004). Cohen and Levinthal (1990) supported this view. They found that up-skilling personnel with intensive and repeated deep learning allowed them to develop absorptive capacity, but required prolonged investment and continual knowledge accumulation. However, as both Romijn and Albaladejo (2002) and Avermaete *et al.* (2004) based their findings on the relationship between innovation and total training expenditure, the effect of different types of training could not be assessed. Therefore, in order to investigate this

[6] No indication is provided by the CIS as to the type or level of qualification (Forfás, 2010:5)

relationship further, it is important to establish which training was engaged in by companies.

4.6.2 Characteristics of a firm's structure and process

It is the internal processes, procedures, and policies to ensure that the information assimilated reaches the appropriate people within the firm, which enables progression through the stages of the absorptive capacity process (Camisón and Forés, 2011; Dyer and Singh, 1998; Zahra and George, 2002). Once effective processes are in place within the firm, the cognitive structures of the individual members of staff integrate to produce an organisational learning capacity (Daghfous, 2004). Social integration mechanisms (SIMs) can be formal (for example, cross-functional teams, see table 4.3) or informal (such as social networks) and build 'connectedness' within the firm (Zahra and George, 2003); with increasing density of linkages thought to instil a culture of trust and cooperation (Fosfuri and Tribo 2008). However, there are also a number of disadvantages, as highlighted in table 4.3.

Table 4.3: Advantages and disadvantages of cross-functional teams

Advantages
Facilitate interaction between key players (Cormican and O'Sullivan, 2004) Facilitate communication between technical staff and marketing (Sarkar and Costa, 2008; Stewart-Knox and Mitchell, 2002) Improve customer focus (Cormican and O'Sullivan, 2004) Improve flexibility (Cormican and O'Sullivan, 2004) Reduce cycle-time and time-to-market (Cooper and Edgett, 2008) Improve outcome from innovation activities (Sarkar and Costa 2008; Tepic *et al.*, 2009) Facilitate a culture of trust and cooperation within the firm (Cormican and Sullivan, 2004; Fosfuri and Tribó, 2008, Stewart-Knox and Mitchell, 2003B) Allow for autonomous team decisions (Tepic *et al.*, 2009)
Disadvantages
Lack of shared understanding, focus and dedication to the project (Cooper *et al.*, 2004; Cooper and Edgett, 2008; Cormican and Sullivan, 2004) Emergence of 'groupthink' and resultant suppression of "creative tension needed for NPD vitality" (Brochman, *et al.* 2010)

The strength of interpersonal ties between members of a group was described by Hogg (1992) as team *cohesiveness*. Brockman *et al*. (2010) asserted that high levels of team cohesiveness facilitated connection between individuals from disparate parts of the organisation, and the emergence of a common goal. However, '*groupthink'* ("strong level of concurrence-seeking among group members") could also emerge, and as a result, the "creative tension needed for NPD vitality" would be suppressed (Brockman, *et al.* 2010:208 and 201). This suggests that, while a high density of communication linkages may improve incremental innovation performance, more radical innovations may suffer from a constrained ability to "think outside the box" (Song *et al,* 2011:13). Camisón and Forés (2011:3) further developed this idea, stating that "over time, decision-making processes become routine and behaviour patterns more rigid, resulting in a drop in the diversity of information that a firm acquires". The importance of "more flexible strategic plans" for NPD was stressed by Song *et al.* (2011), who found a significant negative correlation between strategic planning and the number of NPD projects. However, the same authors also found a positive relationship between strategic planning and improved firm performance. Therefore, a balance between cohesiveness and friction within companies is desirable, but may be difficult to attain.

Furthermore, internal cognitive, behavioural, political and structural barriers can interfere with successful communication in companies (Fosfuri and Tribo 2008). For example, Cohen and Levinthal (1990) highlighted the need for an overlap in knowledge level in order to facilitate information sharing within the company. Nevertheless, a common internal language, that is overly company specific, can preclude the understanding and integration of external knowledge. Behavioural and political barriers may arise due to strained relationship dynamics within the firm.

While Sarkar and Costa (2008) encouraged the utilisation of cross-functional teams in the food industry, the high proportion of SMEs in this sector may diminish the possibility of utilising this important aspect of an innovative environment (due to time and resource constraints). However, the smaller size of the company may also facilitate such teams due to close proximity and lower number of people involved. However, Costa and Jongen (2006) opined that inter-organisational coordination of NPD efforts was not well developed in the food industry, and this may represent a stumbling block for innovation success.

4.6.2.1 Gatekeepers

Cohen and Levinthal (1990) highlighted the important role of 'gatekeepers' in firms, either acting as an interface with the external environment, or as a mechanism for sharing information between internal subunits of the firm. They outlined how the structure of the company influenced the need for a gatekeeper. Fragmented companies, in which the expertise is widely dispersed, were thought to be in greater need of an internal mediator. Conversely, a mediator to the external environment may be in greater demand in companies in which there is a large difference between levels of internal and external knowledge (Daghfous, 2004). However, the absorptive capacity of the firm becomes a function of the capacity of the "individuals who stand at the crossroad of the firm and the external environment" (Spithoven *et al.,* 2010). In addition to this, for the firm to get benefit from the gatekeeper, the other members of staff must have a sufficient level of knowledge to understand and recognise the value of the information provided (Cohen and Levinthal, 1990). Within the context of the food industry, in which non-dedication of resources to R&D and low levels of human capital are thought to prevail (see table 4.1), an individual who can bring fresh ideas and a strategic outlook to the company may be even more essential (Avermaete *et al.*, 2004).

4.6.3 Firm Strategies

The role of firm strategies in discerning specific value from the abundance of available knowledge was stressed by Lane *et al.* (2006). He contended that, depending on the strategy of a company, different types of information are targeted and adopted. Overburdening of product portfolios can be reduced by the prioritisation of high value projects, and cessation of low value projects (Bitman *et al*, 2005; Cooper and Edgett, 2008; Cooper *et al.,* 2004; Roupas, 2008).

The concept of a strategy for innovation has been extensively studied by Cooper and colleagues (Cooper *et al*. 2004; Cooper and Edgett, 2008). They proposed that a strategy for innovation must have a number of key elements to create a successful culture of innovation, including a supportive environment for innovation, open communication and rewards for staff (see table 4.4 for a developed list, including input from a number of different authors).

Table 4.4 Culture and social climate elements that support innovation

General Elements	***Actions to promote positive climate***
A supportive climate for entrepreneurship and product innovation	'Skunk works' and unofficial projects encouraged
Rewards for champions	Resources available for creative work
Rewards for project teams	Time off or scouting time
Open communication	New project ideas rewarded
Low risk averseness	A new project suggestion scheme
No punishment of failure	

Source: developed from Anderson, 2008; Cooper *et al.,* 2004; Cormican and Sullivan, 2004; Roupas, 2008

The use of rewards to stimulate individuals and teams is enshrined in motivational theory and has been recognised as an effective way of aligning the interests of the employee with those of the organisation (Cormican and Sullivan, 2004). Employee autonomy is also well established in the literature as a means of stimulating employee engagement and productivity (Crabtree, 2004; Crespell and Hanson, 2008; LaPree, 2006; Tepic *et al.,* 2009). An ideation method (*i.e.* a new product idea suggestion scheme for employees), accessible to all levels of staff, in conjunction with resources (time and finances) made available for creative work, were found to create a entrepreneurial climate in large firms (Cooper and Kleinschmidt, 1995). However, the practicalities of such 'skunk works' in an industry which is low margin in nature, lessen the potential application of such an approach. Traitler *et al.* (2011:65) argued that such "blue-sky" projects were a "totally unworkable concept" as employees tended not to prioritise such "open-ended projects", relegating them behind more pressing deadlines.

However, the creation of a 'strategy for innovation' does not necessarily translate into a 'culture for innovation'. Indeed, the construct of culture is thought to be highly complex (Hofstede, 1980, 2001; Taras *et al*, 2009). However, Lloyd (1998, cited in Daghfous, 2004), noted that a culture for innovation, fostered by empowerment of employees, improved levels of absorptive capacity in firms. O'Regan *et al.* (2006:251) argued that such a culture was an integral part of "fast tracking innovation in manufacturing SMEs". He found that regardless of the focus of the innovation culture (empowerment, external orientation, internal orientation or human resource), those in the upper quartile for culture achieved higher levels of innovation than those in the lower quartile. Although this study was carried out in the electronics and engineering sector, in which SMEs are renowned for high levels of innovation, food industry SMEs could also benefit from a more innovative culture (Roupas, 2008; Traitler *et al.,* 2011). To this end, Camisón and Forés, (2011:80) appealed for SMEs to invest in building a culture "that favours change and innovation".

4.6.3.1 Managerial input into new product development

Senior management are thought to have a central role in innovation within companies (Anderson, 2008; Cooper *et al.*, 2004; Cormican and Sullivan, 2004). Their importance in SMEs was highlighted by Daily *et al.* (2002:391) who asserted that CEOs tend to "occupy a position of unique influence, serving as the locus of control and decision-making". O'Regan *et al.* (2006) and Koc (2007) found that strong leadership, by focusing efforts on innovation, had a positive influence on innovation in a company. It is important that managers are involved in creating vision, fostering cooperation across the company, providing strong support and empowering employees (Anderson, 2008; Buckler and Zien, 1996; Cooper *et al.*, 2004; Cormican and Sullivan, 2004). Positive relationships between employees and management are recognised as one of the foremost factors for ensuring employees are engaged and thus innovative (Crabtree, 2004). The literature also notes the importance of ease-of-access to senior management when difficulties arise and when major decisions are needed (Cooper and Kleinschmidt, 1995).

Interestingly, the impact of involvement of senior management in NPD is not clear-cut within the context of the food industry. A number of studies have found direct involvement of management in NPD to be predictive of successful innovation (Kristiansen, 1998; Hoban, 1998). However, Stewart-Knox and Mitchell (2003) found this to be unrelated to product innovation success, a finding the authors attributed to the larger number of SME participants in their study. In SMEs, the manager may have a shorter term, tactical, as opposed to a longer-term, strategic role (Stewart-Knox and Mitchell, 2003).

4.7 INTERSECTING FACTORS WHICH LINK THE INTERNAL AND EXTERNAL FACTORS

When engaging in the absorptive capacity process, both the nature of the relationship between collaborating organisations, and the difference in characteristics of the two entities, impacts on the success of the venture (Lane *et al.*, 2006).

4.7.1 Characteristics of internal and external knowledge

Various studies have proposed that similarity in terms of learning level and organisational characteristics (for example, comparable cognitive structures and strategies, similar culture, shared language and common skills) are associated with more successful collaborations (Mowery *et al.* 1996; Lane and Lubatkin, 1998; Sirmon and Lane, 2004).

The degree of information asymmetry between industry and publicly-funded research institutes is thought to contribute to a lessening in the potential benefits from research (Bishop *et al.*, 2010). The collaborations with the greatest potential are thought to involve organisations with similar basic knowledge bases, but possessing different (but complementary) specialised knowledge (Lane and Lubatkin, 1998). To develop commonalities, a broad range of knowledge is needed, aided by developing a bedrock of internal knowledge through R&D (Cohen and Levinthal, 1990; Fosfuri, 2009). Fosfuri and Tribo (2008) agreed with this premise, suggesting that a firm that was actively pursuing NPD could better understand the complexity behind competitors' new offerings. The authors also asserted that frequent use of external knowledge sources develops a firm's ability to search for and identify new external knowledge (*e.g.* R&D employees who have published in scientific journals are more likely to utilise this valuable knowledge source). Therefore, in order to reduce the gap in knowledge between collaborating organisations, active development of absorptive capacity is advisable. Moreover, Bishop *et al*. (2010) found that the ability to benefit from external research was more greatly influenced by conducting continual R&D, than R&D intensity (calculated as the ratio of R&D employees to total employees). This gives credence to the assertion that investment in R&D will position a company more favourably in terms of benefiting from external sources of innovation. This may be attributed in part to the development of sustained relationships between employees involved in R&D and those in engaged in the relevant areas in TLIs.

Dissimilarity in culture between industry and research organisations was also found to be interfering with successful collaborations in a recent Irish study (O'Reilly and Henchion, 2010). For example, performance measures in academia were found to be focused on achieving academic publications and funding; conversely, industry goals were aimed at achieving technology transfer and commercialisation of results, deliverable which were not afforded the same level of recognition in academic career progression. Similar issues were highlighted by Siegel *et al.* (2007) in the US. Demands for "short term solutions rather than longer term research objectives" were seen as evidence of "short-sightedness" prevailing in industry (O'Reilly and Henchion, 2010:11). Furthermore, the fast pace and high expectations of industry regarding development time-lines were cited as specific barriers to success. Alternatively, companies may be opting not to engage with research providers due to the perceived low return on investment or level of resources needed. The gap, in terms of learning level and organisational characteristics, could aid in understanding the variable success rates of collaborations between third level institutes and companies and warrants further investigation.

4.7.2 Characteristics of learning relationships

Although information is abundantly available, in order for a firm to acquire information of most worth to itself it is imperative that they develop a network of relevant, valuable contacts. Dyer and Singh (1998) discuss developing sustained competitive advantage through inter-firm linkages and stressed the importance of the relationship between collaborating firms. Furthermore, O'Reilly and Henchion (2010) found personal relationships between researchers and industry were key in mediating the success of technology transfer between universities and industry. This develops on work by Szulanski (1996) in which it was found that an arduous relationship between source and recipient was a significant barrier to success. Chen (2004) and Asproth and Nuström (2008) also highlighted the importance of trust when engaging in collaborations, with opportunistic behaviour proposed to be detrimental to the relationship. An area of debate in the literature relates to the optimal strength of connections between the firm and collaborating organisation. Zahra and George (2004) proposed that only strong ties with external organisations positively influence absorptive capacity. Conversely, Todorova and Durisin (2007) propose that far ranging weak ties are more effective, as they provide access to a wide range of information and connect groups which would not otherwise integrate. The divergence in findings may be explained by the differing levels of innovation occurring. Henchion *et al.* (2011) posited that closed, dense networks were more supportive of high levels of innovation, such as radical technological innovations with associated IP outcomes, than weaker networks.

In the last two decades, technology transfer offices (TTO's) have emerged as a mediator between TLIs and those who can potentially commercialise discoveries (*i.e.* firms, entrepreneurs, and venture capitalists) (Siegel *et al.*, 2007). However, a number of issues arise for TTOs as they strive to capture the value from the TLI's discoveries.

In the US, an issue of non-disclosure of technologies to the TTO's was highlighted by Thursby *et al*. (2001). This is despite the Bayh–Dole act, which stipulates that scientists must file an invention disclosure. Furthermore, the lack of incentives to get involved in technology transfer activities was also identified as a barrier by Siegel *et al. (*2007) in the US and by O'Reilly and Henchion (2010) in Irish universities and research institutes. In addition, information asymmetry between industry and academics as to the value of the invention can inhibit this process and the average technology transfer employee cannot be *au fait* with deal structures of all sectors. The multidisciplinary nature of the interaction between different departments in the TLIs and different industry representative creates a challenging environment for those working in TTOs. In addition, the involvement of a third party in the transaction can interfere with the development of strong relationships between researchers and industry. As such relationships have been linked with successful technology transfer (O'Reilly and Henchion, 2010), this may impact on the outcome of the transfer of knowledge, particularly in terms of tacit knowledge.

4.8 ABSORPTIVE CAPACITY OUTCOMES

The process of absorptive capacity is thought to be dynamic, and involve constant feedback from the different stages and actors (Todorova and Durisin, 2007; Zahra and George, 2002). As a result, the priority placed on outcomes may also become a driver for investing in absorptive capacity. Lane *et al.* (2006) suggested examining both the commercial outputs (*e.g.* new products, patents and increased market share) and the knowledge outputs (*e.g.* scientific, technical and organisational outcomes). The commercial benefit of investing in a new technology is believed to be a major driver of the decision to invest (Cohen and Levinthal, 1990). The knowledge outcome is thought to contribute to Cohen and Levinthal's (1990) 'bedrock of knowledge', and thus enhance the absorptive capacity of the firm. This factor has been somewhat ignored in the literature in the intervening years, despite Cohen and Levinthal (1990) stressing its importance. This may be due to the relative complexity of measuring the knowledge-based development, as opposed to enumerating patents and citations when measuring the commercial aspect. When criticising the Zahra and George (2002) model, Lane *et al.* (2006) asserted that defining absorptive capacity solely in terms of commercial outputs reflected a short term view, and did not take into account the development of a knowledge base within the firm.

4.9 CONCLUSION

In today's market, the use of external sources of information is believed to be imperative to the survival of companies, not excluding those in the food industry (Porter, 1998; Sarkar and Costa, 2008). Although necessary for competitiveness and survival, the decision to invest in external sources of information is a complex one. However, as pointed out by Camisón and Forés, (2011), companies without a developed level of absorptive capacity cannot identify the potential of external knowledge for creating competitive advantage. Absorptive capacity enables not just imitation of other firms' products and processes, but also the ability to exploit "less commercially focused knowledge" (Lane *et al.,* 2006:833) (for example the research arising from third level institutes). Therefore, the Lane *et al.* model (2006) of absorptive capacity provides an excellent starting point for the investigation of the factors modulating the decision by food companies to invest in technological innovations emanating from publicly-funded research centres.

According to this model, a number of factors which influence the environment in which the company operates affect absorptive capacity. Furthermore, the knowledge and non-knowledge characteristics of collaborations with external sources are also influential. Internal antecedents include human capital, strategies, structures and processes within the firm. Finally, brief mention is given to the outcomes, both knowledge and commercial, that arises from taking on a new technology and how this improves firm performance. In addition, this literature review utilises the diffusion of innovation theory to further develop the process of absorptive capacity. However, there is a paucity of studies relating directly to the food industry and to SMEs in the food industry, and this was taken into account over the next stages of the research.

Chapter 5

Methodology - 1 - Research Design

5.1 INTRODUCTION

The purpose of this chapter is to outline how the methodology for this research was developed and implemented. Initially, the cross-sectional, mixed method approach which was used to conduct the three phases of primary research is explained and justified. The procedure for conducting the first round of qualitative research is detailed. Following this, the development of the data collection instrument and the statistical methods used to analyse the data are described. Finally, the process for the final qualitative research stage is outlined.

5.2 REITERATION OF THE OBJECTIVE OF THE STUDY

The central research question of this study is to uncover and determine the degree that environmental and internal factors influence the assimilation of technological innovation by Irish food companies. In order to facilitate the understanding of this question, the following issues will be pursued:

1. Perceptions among the Irish food industry regarding the benefits and feasibility of technological innovation
2. Awareness of the mechanisms which facilitate uptake of technological innovation among Irish food companies
3. Perceptions of the current business environment by companies in the Irish food industry
4. Current innovation capacity of Irish food businesses

5.3 DEVELOPMENT OF RESEARCH DESIGN

5.3.1 Cross-sectional study

As this project aims to get a picture of the current factors influencing technological innovation engagement, a cross-sectional design was deemed to be the most appropriate format. Bryman and Bell (2007) describe how this type of study involves the collection of data on a number of variables pertaining to a set of cases, at a single point in time, in order to detect patterns of association across cases (*i.e.* looking at the current situation rather than any change or trend over time).

5.3.2 Qualitative, quantitative and mixed method research

A cross-sectional study can involve the use of qualitative, quantitative or mixed methods. Although each method has particularities, Newman and Benz (1998) opined that the three methods are best considered as stages lying along a continuum, with qualitative research concerned with describing meaning and the quantitative variety associated with the scientific approach.

Morgan (1998) outlined how the mixed method approach integrates the complementary strengths of the different methods, and in doing so enhances and enriches the understanding of a subject. This was further developed by Flick (2006), who proposed that qualitative methods could be used to elucidate and investigate the relationships discovered initially by quantitative research. Creswell (2009) suggested that the mixed method approach reduced the biases inherent to each technique. For example, due to the smaller sample size limitation usually involved in qualitative research, the wider applicability of results generated may be open to question (Flick, 2006). The complementary use of quantitative research, enabling larger numbers of subjects to be reached more rapidly and economically, may go some way to addressing this deficit. Other benefits of the mixed method approach include being able to use the results from one to identify participants for the other method, and using the results from one to support the results of the other (*e.g.* using qualitative observations to consolidate or refute quantitative statistics) (Creswell, 2009). Also, Miles and Huberman, (1994) have suggested that quantitative research can help by supplying background data, and uncovering previously overlooked information, while qualitative research can enhance a study by aiding in conceptual development, and providing a holistic account of the issue under study. One of the aims of this research was to get a comprehensive picture of the current innovation capacity of Irish food companies. To ensure sufficient numbers were reached in order to achieve a representative sample, a quantitative approach was deemed to be beneficial (due to the lower costs and resource requirements). However, issues such as perceptions of the benefits and feasibility of technological innovation, or awareness of the mechanisms which facilitate innovation, are more sensitive in nature. Therefore, results are more difficult to assess with a purely quantitative approach and require the use of qualitative techniques (such as probing, mirroring and open-ended questions) to investigate fully. The mixed method approach can reach sufficient numbers to give a representative view of the food industry, while concurrently enriching the understanding of issues faced by the players in the industry by means of in-depth analysis. In this way, it can overcome the biases intrinsic to both quantitative and qualitative research. Therefore, it was selected for use in this study.

Morgan (1998) advised, as a practical approach to combining the methods, the assignment of priority to one method, and a subsequent decision regarding the sequence of the steps. The prioritised method forms the principle means of data collection, the strengths of which will best accommodate the research goals, while the subordinate method is then designed to support this strategy. The question of sequencing addresses how best to integrate the different types of data collected, so that what is learned from the application of one method consolidates the findings of the other (Morgan, 1998). For a summary of the different sequencing and priority options for a two step research process see figure 5.1.

Sequence Decision	**Priority Decision** ***Principal Method:*** *Quantitative*	***Principal Method:*** *Qualitative*
Complementary Method: *Preliminary*	***1.* Qualitative Preliminary** qual ➔ QUANT ***Purposes****:* Smaller qualitative study guides data collection in a principally quantitative study, can generate hypothesis, develop content for questionnaires etc.	***2.* Quantitative Preliminary** quant ➔ QUAL ***Purposes***: Smaller quantitative study helps guide the data collection in a principally qualitative study, can guide purposive sampling, establish preliminary results to pursue in depth
Complementary Method: *Follow-up*	***3.* Qualitative Follow-up** QUANT ➔ qual ***Purposes****:* Smaller qualitative study helps evaluate and interpret results from a principally quantitative study, can provide interpretations for poorly understood results, help explain outliers	***4.* Quantitative Follow-up** QUAL ➔ quant ***Purposes****:* Smaller quantitative study helps evaluate and interpret results from a principally qualitative study, can generalise results to different samples, test elements of emergent theories

Figure 5.1 Complementary combinations of qualitative and quantitative research: The priority-sequence model (Abridged version of Morgan, 1998:368)
Capitals = prioritised method

Miles and Huberman (1994) presented a 3-step variation of this model (figure 5.2) that begins with explorative qualitative fieldwork, and which is then used to develop and refine an instrument for measurement. Following this, a quantitative data collection process is undertaken (*e.g.* through a questionnaire). Finally, a further qualitative investigation can develop and enhance the results of the previous round. This model is demonstrated in figure 5.2 below.

qual $\longrightarrow$	quant $\longrightarrow$	qual
(exploration)	(questionnaire)	(deepening and assessing results)

Figure 5.2 Illustrative design linking qualitative and quantitative data (Miles and Huberman, 1994:41)

On the basis of the analysis of such recommendations, it was decided that a quantitative study, in the form of a large-scale questionnaire distributed to food companies in Ireland, would form the principal data collection method. It was felt that this method of collection would reach the greatest number of potential participants which fit the criteria required and thus give a representative picture of Irish food SMEs. Initial development of the quantitative approach was supported by a comprehensive review of the literature, followed by a series of preliminary qualitative interviews designed to narrow the focus of the instrument of measurement. It was decided to conduct a number of interviews prior to the large scale data collection in order to test whether the model chosen included all relevant points of interest to the study. The survey was then executed, followed by a second round of interviews aimed at developing the understanding of the quantitative findings. Figure 5.3 outlines each research stage.

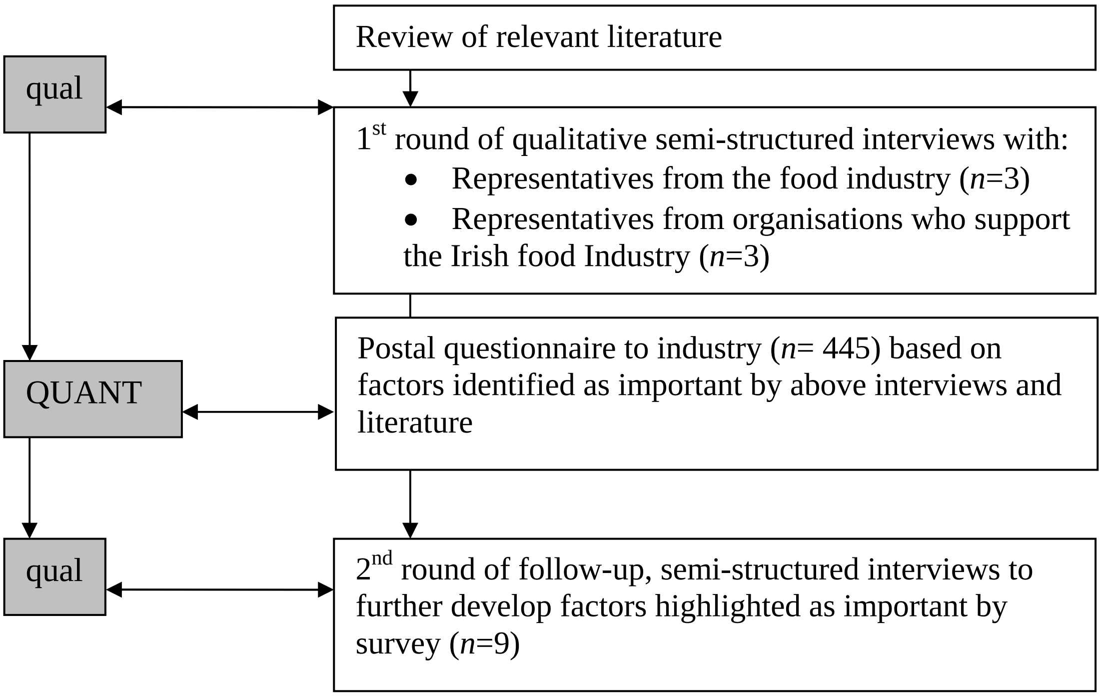


Figure 5.3 Research design flow chart
Capitals = prioritised method

5.4 LITERATURE REVIEW

A critical review of relevant literature formed the basis for the primary[7] data collection stage. The objective of the review was to identify and gain an understanding of the factors involved in influencing industry acceptance of novel technology. In doing so, the drivers and barriers to technological innovation were highlighted. Following this, in order to set the context for the research, the current level of innovation occurring, both internationally and nationally, and within the food industry, was established. It was also essential to establish the working definition of innovation to be used for the purpose of this study. To do this, an understanding of the complex innovation literature was needed. The discussion on the current state of innovation and the definition to be used in this study are presented in Chapter 3. Chapter 4 focuses on the factors influencing technological innovation, and is based on the model for absorptive capacity developed by Lane *et al*. (2006).

[7] Primary data are data derived from a new research study; whereas, secondary data are data that are already available (Crimp, 1985)

Initial review of prior literature (Chapter 4) indicated a paucity of studies relating specifically to the food sector; the extrapolation of findings from high technology, large companies to a low-technology industry dominated by SMEs, was found to be commonplace in the literature. Such studies span a diverse range of topics: innovation adoption, diffusion and management; technology transfer; absorptive capacity; and change management. With a view to reconciling the results of such studies, and the proposed model for technological innovation, with the specific context of the Irish food industry, a series of in-depth interviews were conducted with representatives from industry and government support agencies. In addition, the interviews facilitated the examination of the limitations of the original model and modulation of the terminology used to ensure its relevance to the food industry. The interviews, in conjunction with the literature, also assisted in the construction of the hypotheses for the research.

5.5 PRIMARY RESEARCH: EXPLORATORY INTERVIEWS WITH INDUSTRY AND RESEARCH REPRESENTATIVES

5.5.1 Instrument

A semi-structured format of interviewing was used to conduct the exploratory interviews in order to ensure the topics of interest were covered within the time frame of the interview, while allowing for the flexibility to discuss topics which arose over its course. A semi-structured interview guide allowed for easier interpretation of the data during analysis than allowed by unstructured interviewing (Creswell, 2009). The recommendations of Flick (2006) were followed, whereby the initial approach with interviewees deployed open-ended questions contextualized against several current topical industry themes (identified from the literature), with subsequent narrowing of question focus as the interview progressed. The status of the interviewees as authorities in the food industry is of particular interest in this study. Thus, respondents occupied senior positions in management of food companies or in agencies supporting the food industry, and were known to have spent a considerable portion of time working in the industry. Therefore, these interviews can be said to be ‘expert interviews’. Flick (2006) highlighted that the main issue arising with expert interviews was the ability of the interviewer to restrict the expert to the topic of interest. To facilitate this, an interview guide was used in the present study. The possible disadvantages of this approach identified by Creswell (2009) (encompassing problems relating to possible bias emanating from interpersonal communication/perceptual issues) were controlled for by careful design of questions and prompts.

The topics covered in the interview guide were sourced from the absorptive capacity literature discussed in Chapter Three, and covered the following: factors external to the firm which impact on the business operating environment; factors internal to the firm which facilitate or inhibit technology uptake; factors intersecting both the internal and external environment; the outputs desired from engaging in technological innovation. The compilation of the semi-structured interview guide began by constructing questions which would investigate each of these various aspects. These questions started with an open-ended format, with prompts to enable further exploration of issues highlighted. The interview guide was reviewed by members of the research team and the advisory group, with secondary review for meaning and understanding by colleagues external to the team. Possible issues with question meaning/language, omission of issues of interest, and the presence of questions likely to create bias, were identified and corrected at this stage. A number of questions were modified to allow for greater flow of conversation. Small content variations between industry and non-industry interview guides were necessary to take account of differences in core activities. For example, although the industry interviewees were targeted as representatives of the food industry, a number of the questions were company-specific (*e.g.* what are the most innovative aspects of this company's products?/I understand this company is quite decentralised, how does this impact on taking on a new technology?). This is in contrast to the more general nature of the industry-sectoral questions (*e.g.* what role does innovation have in the food industry?/looking at the decision making structure of food companies, how does this impact on taking on a new technology?).

5.5.2 Pilot study

When the preliminary semi-structured interview guide was completed, a pilot interview was conducted with a member of the food market research team in Teagasc Food Research Centre, Ashtown. The results of the pilot established that the interview duration would be between 45 and 60 minutes which was deemed acceptable. The final interview guides are presented in Appendix II and III.

5.5.3 Sampling framework

Purposive sampling was used to select the participants for the qualitative research. This type of sampling "chooses subjects who, in (the researchers') opinion, are relevant to the project" (Sarantakos, 2005). Bryman and Bell (2007) advise caution when using such non-probability sampling, due to the possibility of bias arising from the subjective manner in which candidates are selected. However, Sarantakos (2005) points out that this method of sampling ensures that the interviewees have the necessary knowledge and experience to answer the questions outlined in the interview guide. Additionally, it enabled the selection of a sample that had the ability to reflect and articulate information, a criterion suggested as indicative of a "good informant" by Flick (2009).

A proprietary directory from Teagasc of food industry contacts (with updated internet search verification) was used to select three food companies for study, the profiles of which are presented in table 5.1. The major selection criteria for company inclusion in the study were as follows:

1. *Manufacturing base in Ireland*: In order to orientate the research specifically within an Irish context, it was decided to limit potential interviewees to companies operating a manufacturing base in Ireland. National development policy stresses the uptake of innovation by firms manufacturing goods within Ireland with a view to providing jobs and strengthening international competitiveness.
2. *Perceived innovation capacity:* By targeting companies with varying levels of innovation, the differing perspectives of such stakeholders could be established and compared, allowing the identification of areas for further investigation. In order to obtain an indication of the level of technological innovation in the selected companies, an internet, patent and commercial literature search was conducted to uncover evidence of recent product, process and packaging innovations[8]. This approach was chosen due the difficulties in attaining empirical data on the innovation level of companies in Ireland as the results from the innovation surveys carried out (such as the Community Innovation Survey) are confidential. Companies with greater evidence of such innovations were assumed to have higher innovation levels than those who had not. Due to

[8] This search was conducted using the Google search engine and included examination of the An Bord Bia website, online national and local newspaper archives, trade publication websites (*e.g.* Check-out magazine, Shelflife.ie, todaysgrocery.com), company websites (original company and competitors), retailer websites (*e.g*. SuperValu.ie), campaign websites (*e.g.* Love Irish Food, Organic-trust.ie, slowirishfood.ie), food research website (*e.g.* RELAY, Teagasc, UCC, UCD), and trade organisation websites (*e.g.* Irish Exporters Association).
Key words included: innovation, innovative, new, original, novel, pioneering, ground-breaking, product, process, packaging, research, research and development, new product development, NPD, awards, awarded, Bord Bia, IFA, Enterprise Ireland, grant, R&D grant.

the subjective nature of this measure, it was termed *perceived* level of innovativeness. The results of this search are omitted from the appendix in order to maintain the anonymity of the companies interviewed.

3. *Specific product portfolio-focus:* In addition to the global issues which impact on the industry as a whole, each sub-sector of the food business faces particular issues. By purposely selecting companies from different sectors, an insight into these unique factors can be gained.
4. *Geographical location:* For logistical reasons, companies in Dublin or the surrounding areas were targeted for this round of interviews.

Table 5.1 Profile of company representatives that were involved in the semi structured interviews

Code	Position of interviewees	Company Location	Product portfolio Focus	Perceived level of innovation
Firm 1	NPD Manager	Dublin surrounding area	Ambient snacks	High
Firm 2	MD and NPD Manager	Dublin	Ingredients	Medium
Firm 3	NPD Manager	Dublin	Vegetable processor	Low

In the smaller companies, the managing director was targeted for interview. Contrastingly, in the larger companies, the R&D manager or NPD manager was selected for interview. It was felt that such targets would have the appropriate knowledge set to answer the questions posed in the interview.

In addition, three representatives from organisations that support innovation in the Irish food industry (through grants, training and advice) were selected for study in order to get an overview of the industry in general. All occupied pivotal positions in the industry and had extensive experience working in the area.

5.5.4 Data collection and analysis

The six interviews were conducted by one researcher and lasted between 45 minutes and one hour. All but two interviews took place in the interviewee's workplace. The remaining interviews took place on site in the Teagasc Food Research Centre, Ashtown. All were recorded using an Olympus WS200-S Voice Recorder. Directly after each interview a contact summary sheet was completed by the interviewer in which the key emerging themes and reflections were noted (see Appendix IV).

The interviews were transcribed *verbatim* by the same researcher. Interviewee names were coded due to the confidential nature of the information discussed. An inductive approach to analysis, in which themes emerging from the data were considered in terms of the original Lane *et al.* (2006) framework, ensured that existing factors were incorporated, and the framework was expanded to integrate novel themes. In order to facilitate this, the text was examined using a constant comparison analysis as described by Boeije (2002). This analysis took place in three stages: 1) content analysis of each individual interview (in which emerging themes were internally compared for agreement and contradiction); 2) comparison between interviews within the same group (*i.e.* within the industry and the non-industry groups); 3) comparison of interviews between groups (industry versus non-industry). The analysis was conducted using NVivo qualitative data analysis software (QSR International Pty Ltd. Version 8, 2008). A discussion of the conceptual development of a modified version of the Lane *et al.* (2006) model, which was used as the basis of the questionnaire, is presented in chapter five.

5.6 PRIMARY QUANTITATIVE RESEARCH: RESEARCH QUESTIONNAIRE – NATIONAL SURVEY OF COMPANY INNOVATION ACTIVITIES

5.6.1 Data collection instrument

Building on the literature review, a data collection instrument was constructed in the form of a postal survey. A number of considerations were taken into account when deciding to conduct the postal survey. Domegan and Fleming (2003) outlined the available options when conducting a cross-sectional survey as follows: personal interview, telephone, postal, e-mail and web-based. As this survey aimed to get a picture of the current innovation practices in Irish food companies, it was important to reach a representative sample of such companies. The cost and time implications associated with personally interviewing such a large sample eliminated this approach. Telephone interviews have gained popularity in recent years, resulting in the implementation of call screening in many companies. As this questionnaire targeted senior managers in each company, who have restricted availability, it was decided that a postal questionnaire which could be perused at the recipient's convenience would be more suitable, and also have an increased chance of reaching the intended respondent. Additionally, the cost and time involved in interviewing 445 companies by telephone would have been prohibitive.

Web-based questionnaires have been found to be viable alternatives to postal questionnaires. Domegan and Fleming (2003) described the benefits of such an approach as follows: reduced cost (printing and postage costs are eliminated), the ability to produce the survey in an attractive format, to make it easy and quick to complete (by not showing non-applicable questions) and the possibility of including graphics, sounds or video to maintain interest. However, it was felt that using a web-based questionnaire may bias the respondents to those who were intrinsically more innovative, in being ‘early technology adopters’. Further to this, a decline in response rates to web-based surveys has been noted since the first web-based survey in 1986 (Sheehen, 2001).

Additionally, if an e-mail survey was used, the difficulty in ensuring anonymity of responses, while attached to an e-mail address with the respondents’ name, was another area of concern. As confidentiality was a central premise in the attempt to elicit sensitive information from companies, it was believed that this could compromise the integrity and the success of the study. In the light of these considerations, it was decided that a postal questionnaire was the best option for this population.

The final questionnaire comprised twenty-eight questions. These were primarily close-ended, multichotomous questions with a small number in open-ended format, as it is best to minimise the number of the latter in postal surveys (see Appendix V). A number of recommendations regarding the optimum sequencing of questions, as per Domegan and Fleming (2003), were incorporated. These included: arranging group-related questions together; enquiring about present behaviour before past behaviour; placing questions with similar format together while avoiding tedious sequences of questions (*e.g.* too many Likert scales together); deploying ‘skip’ questions where appropriate (*e.g.* If NO, please skip to Q7.); ensuring sensitive or complicated questions were located deep within the questionnaire, and leaving questions of a categorical nature to the end (*e.g.* company size, job title).

The questionnaire was divided into three sections:

1. *The main section:* (Q1-20) posed a range of open and closed-ended questions covering all aspects of the model derived from the combination of the literature review and preliminary interviews. Where applicable, closed-ended questions were followed by an ‘other’ option to facilitate

responses that did not fit with the defined options provided in the question.

2. *Company Background Details:* (Q. 21-25) used closed-ended, tick-the-box type questions to catalogue metrics such as company sector, exporting status, activities and size (employee number and turnover).
3. *Personal Details*: (Q. 26-28) used open-ended questions to log job title and respondents' personal history with their company, and career within the sector.

The questionnaire ended by thanking the respondents and providing a space for open-ended comments pertaining to the subject of the questionnaire.

In recognition that the response rate to a survey can be greatly influenced by the appearance and layout, particularly for postal surveys (Domegan and Fleming, 2003), the following strategies were deployed: using booklet form; ensuring each question was not split over two pages; including clear directions and instructions; numbering questions sequentially. Edwards *et al.* (2002) suggested a professional looking questionnaire, printed on high quality paper, resulted in an increased response rate. As a result, this questionnaire was professionally printed in full colour with consultative input from the printer regarding the best paper to use. Considerable planning also went into the title: "Research Questionnaire – National Survey of Company Innovative Activities". It was hoped that avoiding the term *technological* in the title would reduce the chance of recipients disregarding the questionnaire, believing it was not relevant to their activities. In addition, the word *National* was included to raise the profile of the questionnaire. As a number of studies have shown that a university sponsor increases response rate (Chawla *et al.*, 1992; Faria and Dickinson, 1992; Schneider and Johnson, 1995), logos for the three organisations involved in the project were placed in a prominent position on the front page. Despite the popularity of including monetary rewards, conditional or unconditional, to increase response rates (Dillman, 1978; Edwards *et al.*, 2002; Connon, 2008), Schneider and Johnson (1995) contended that the utility of monetary incentives may have limited impact in business studies. As a result, this method of increasing response rate was not pursued. However, the companies were offered a summary of the key findings of the survey as an incentive for participating.

5.6.2 Pilot Study

The questionnaire was piloted in two stages. Initially, an internal pilot involving two members of the Teagasc food market research unit, and one member of the DIT faculty, was conducted. Opinions on the layout and formatting of the questionnaire were incorporated into the final output.

Following this, a second pilot questionnaire was posted to three representatives from the Irish food industry. As per procedure for the full survey, the cover letter and RELAY[9] update were included. Recipients were asked to assess whether any issues arose regarding completion or ease of understanding of the questionnaire. Feedback from the industry pilot criticised the length of the questionnaire, which took up to 30 minutes to complete. However, all questions were deemed understandable and relevant to the study aims. As a result of this, a number of questions were shortened and others which were felt to overlap with other questions were deleted. In addition, on advice from a respondent, an extra column, ‘not relevant’, was added to the question regarding uptake of specific types of novel technology to differentiate between companies who were unaware of the technologies and those for which the technology was irrelevant.

[9] RELAY is the national dissemination service which communicates the results of publicly-funded food research to the Irish food industry and further information can be found at: http://www.relayresearch.ie

5.6.3 Sampling framework

The proprietary directory of specific food industry contacts (managing directors of smaller companies and NPD, R&D or technical managers of larger companies) was again used to identify 445 food companies operating in Ireland. Companies were limited to those with more than ten employees, who had a food manufacturing operation in Ireland, and thus excluded food retailers and MNCs operating a distribution function from here (*e.g.* Mars and Kelloggs).

5.6.4 Data collection

In order to maximise response rate, many of the steps in Dillman's (1978) *Total Design Method* (TDM) were adhered to. Dillman suggests an initial pre-approach letter to create a sense of positive anticipation. A project update was circulated to companies on the 30th April 2010 by RELAY and the pre-approach dove-tailed with this (Appendix VI). In early July 2010, 445 questionnaires were posted, accompanied by a cover letter explaining the purpose of the study (see Appendix VII), and also a flyer detailing the overall project. Each cover letter was personalised with the name of the target individual within the organisation, as advised by Connon (2008) and Edwards *et al.* (2002). The personalised direction of the letter depended on the size and structure of each company (*i.e.* in small companies the managing director was targeted, and in larger companies the NPD, R&D manager or the technical manager were approached). The cover letter thanked participants and provided contact details as suggested by Connon (2008). Additionally, the cover letter included a social utility plea, as recommended by Jobber and O'Reilly (1998), which framed the research as beneficial for "national economic recovery". Each letter was printed on official headed paper (Teagasc) and was hand-signed using blue ink. Assurances of confidentiality were provided and facilitated by the coding of each questionnaire, while enabling the researcher to identify which companies had replied. Additionally, a prepaid Business Reply Post (BRP) envelope was enclosed. While the literature suggested that the use of stamped addressed envelopes was preferential to BRP envelopes (Jobber and O'Reilly, 1998), the added time and resource cost negated the use of stamps. All of these measures were implemented to maximise response rate.

As per the TDM, two weeks subsequent to the initial questionnaire, a reminder letter was sent to companies which had not replied (Appendix VIII). Additionally, an e-mail reminder was circulated, by RELAY, to encourage response. At this time, an article relating to the project was also published in the *Ashtown Food Innovator* (Kavanagh, 2010), the Teagasc Food Research Centre newsletter which is circulated to companies within the database.

Following recommendations from the TDM, a full month after the initial questionnaire, a second questionnaire with accompanying cover letter was distributed (Appendix IIX). Although, a third wave of questionnaires is suggested by Dillman (1978), this was not possible within the financial and time constraints of the project. The final cover letter again appealed to food companies to reply for the “national good” and gave a more detailed description of the project. Finally, twenty-four follow-up phone calls with a random sample of non-responsive companies were conducted. This only achieved an additional two responses. However, explanations of non-response were provided from these conversations, with lack of time, large numbers of other surveys received and the impersonal nature of research being cited as mediating factors. This was in spite of the personalised letters which accompanied the survey.

By September 2010, one hundred and twenty-seven completed questionnaires had been returned. In this time, thirteen companies had contacted the researcher and refused to complete the questionnaire, or had returned it blank. Time pressure was the main reason given for refusing to complete the survey. Despite internet verification of the companies in the database, thirty-nine questionnaires were returned to the researcher by the post office. Follow-up on these companies was conducted and it was found that while in come cases no reason for the return could be definitely established, in others the company had moved address, or the individual had left the company. This is reflective of the current dynamic economic environment. The final usable response rate was 30.5% (table 5.2).

Table 5.2: Response rate for questionnaire

	n	*n*	%
Initially sent	445		
Post office return round 1	17		
Post office return round 2	18		
Companies which have closed	11 (46)		
Final Cohort		399	100
Completed (Useable cohort)		**123**	**30.5**
Refused/returned blank		13	3.3
Total responses		135	33.8

5.6.5 Data organisation and cleaning

A database for the management and storage of data was constructed in PASW statistical software for Windows, version 18.0 (SPSS, Chicago, IL). The vast majority of questions were closed-ended, and thus the emerging data were coded and entered into the database. Data were doubly-entered and inspected for errors using a comparative syntax constructed in PASW. Occasional transcription errors were corrected with reference to the original questionnaires (*e.g*. replacing *agree* with *strongly agree*). The responses to the open-ended questions were entered into a separate file in Microsoft Excel (2003). Once all data had been collected, these responses were manually coded and analysed under common themes.

5.6.6 Statistical considerations and procedures

5.6.6.1 Reliability

In order to assess internal consistency of the factors, a value for Cronbach's alpha was established for each scale that was developed. Nunnally (1978) recommended that the Cronbach alpha exceed 0.7 for each scale. However, due to the sensitivity of the Cronbach alpha measure to a low number of items, a measure of mean inter-item correlation is recommended for scales with less than ten items (Pallant, 2007). The optimal range for the inter-item correlation, recommended by Briggs and Cheek (1986), is between 2.0 and 4.0, and was achieved for all scales developed. Inter-item correlation means are presented in the following sectors for scales in which the Cronbach alpha did not achieve 0.7.

5.6.6.2 Data analysis

Summary descriptive statistics of the nominal and ordinal data were presented as frequencies. Continuous data were presented as means, standard deviations, minimum and maximum, unless otherwise indicated. When continuous data was converted to categorical data, the groupings were presented in tables (*i.e*. training spend, R&D spend, length of time with company). In all cases, unless otherwise indicated, pair-wise exclusion of missing values was adopted to maximise the respondents who could be included in the analysis, as suggested by Pallant (2007).

5.6.6.3 Factor analysis and rotation

For a number of aspects of the model, factor analysis was used in order to reduce the variables into a smaller set of composite constructs. Hair *et al*. (1998) described factor analysis as a means of exploring the data, which suggests ways of grouping the data together by defining a set of common underlying dimensions. This smaller set summarises the data and facilitates the interpretation of the original larger set of data. This statistical procedure will identify redundancy in a set of correlated variables. It is particularly useful if several variables measure the same or similar characteristics (SPSS, 2006). Briggs and Cheek (1986) contended that inclusion of redundant variables in factor analysis biases the resulting factors in their favour (*e.g.* in scales measuring culture with a number of variables measuring similar features) and the identification of this redundancy through factor analysis controls for this. Field (2009) outlined how the term *factor analysis* encompasses both principal component analysis (PCA) and factor analysis (FA). In PCA, the derived variables are linear combinations of the original data; in contrast, FA uses a mathematical model in which shared variances are measured. PCA was favoured over FA in this study, as it is deemed to be a psychometrically sound procedure (Field, 2009) and it is mathematically simpler (Pallant, 2007).

Factor rotation was applied in order to further aid interpretation of the emerging components. According to Pallant (2007), rotation can be oblique or orthogonal. Field (2009) described how orthogonal rotation assumes all factors are unrelated and ensures they remain so during rotation, whereas oblique rotation allows factors to correlate. A number of authors have suggested that there is a distinct possibility for correlation between variables in all naturalistic data (Field, 2009; Costello and Osborne, 2005; Melton and Schuklenberg, 2009). As oblique rotation (*e.g.* direct oblimin) allows for the possibility of correlation between factors, it is suggested to be theoretically more accurate than orthogonal rotation (*e.g.* varimax) (Costello and Osborne, 2005; Melton and Schuklenberg, 2009). For this analysis, both options were run, and unless otherwise indicated, the results from direct oblimin (oblique) rotations are presented. Factor analysis produces factor loadings. Kline (1994) recommended that to be taken into consideration, high factor loadings must be greater than 0.6, and loadings above 0.3 are considered fairly high. In this study, the majority of loadings were above 0.6 and those below 0.3 were excluded from further analysis.

5.6.6.4 Cluster analysis

Cluster analysis is a technique used to reveal “natural” groupings within the data based on their proximity to each other (SPSS, 2006:6). It is widely used for market segmentation (the grouping of consumers) in market research. Clustering methods can be classed as hierarchical and non-hierarchical. Hierarchical methods ensure that once observations are clustered together they remain together at all stages; however, non-hierarchical clustering does not impose this restriction. Non-hierarchical, K-means clustering was used in this research due to its popularity in the literature (SPSS, 2000). In this method, the analyser can choose can choose the number of clusters prior to running the analysis. In this way, three tertiles, corresponding to low, medium and high, could be identified.

5.6.6.5 Bivariate analysis

Bryman and Bell (2007) outlined how bivariate analysis is used to investigate the relationship between two variables at a time. Chi-squared analysis is a form of bivariate analysis. In this study, chi-squared distribution tests were used to validate the hypotheses involving categorical variables. Continuous data variables were subjected to Analysis of Variance (ANOVA) separately to identify the significant factors (Field, 2009).

5.6.6.6 Chi-square test

Field (2009:688) characterised Pearson's chi-square as a non-parametric test, which "compares the frequencies you observe in certain categories to the frequencies you might expect to get in those categories by chance". The data are displayed in contingency tables which can be used to facilitate analysis of variables (Bryman and Bell, 2007). Pallant (2007) described how non-parametric tests do not require stringent assumptions regarding the population under analysis (*e.g.* regarding normality). There is no parametric alternative to the chi-square tests for independence.

Pearson's chi-square is given by the equation:

$$\chi^2 = \sum \frac{(\text{observed}_{ij} - \text{model}_{ij})^2}{\text{model}^{ij}}$$

in which *i* represents the rows in the contingency table and *j* represents the columns (Field, 2009).

5.6.6.7 Analysis of variance (ANOVA)

Analysis of variance is a method of comparing the means of two or more groups (Pallant, 2007). Pallant described how this technique compares the variability in scores (variance) between the groups with the variability within the groups (variability caused by independent variable:variability caused by chance). Fisher (1935) outlined that the ANOVA test produces an F-ratio. A large F-ratio translates into higher variability caused by the independent variable (*explained variance*) than by chance (*error variance*) (Bryman and Bell, 2007). If the F-ratio is not significant, the difference in means may be caused by variables other than the independent variable under analysis. If a significant F-ratio is found, Pallant (2007) advised the use of *post-hoc* analysis techniques to uncover which of the groups differ for analysis conducted on more than two groups [*e.g*. Fisher's least significant difference (LSD), Tukey's range test, Scheffé's method].

5.6.7 Measures used in the survey

5.6.7.1 Absorptive capacity measures

At present, the literature does not provide an agreed measure for direct empirical measurement of absorptive capacity (Schmidt, 2010; Lane *et al.*, 2006; Zahra and George, 2002). However, many authors have equated company absorptive capacity with the ability to successfully benefit from knowledge external to the firm (Cohen and Levinthal, 1990; Zahra and George, 2002; Todorova and Durisin, 2007; Schmidt, 2010). Therefore, this study, building on the work of Schmidt (2010), clustered companies into three groups, based on the extent of their absorptive capacity, using two measures: (M1) level of receptivity to external sources of innovation, and (M2) perceived value placed on such sources. These form the dependent variables.

In order to determine the receptivity of a company to external sources of innovation (M1), respondents were asked to rank their level of agreement with five statements (relating to openness to academia, support bodies and publicly-funded research) on a five point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Prior to performing PCA, the suitability of the data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients above 0.3, as recommended by Pallant (2007). The Kaiser-Meyer-Olkin[10] value was 0.6, as recommended by Kaiser (1970). The Bartlett's Test of Sphericity[11] (Bartlett, 1954) also reached statistical significance, supporting the factorability of the correlation matrix. PCA, using direct oblimin rotation, was then conducted to investigate how the statements loaded together (table 5.3). As one of the statements loaded strongly on both components, this statement was removed and the analysis was repeated (*If your company was to collaborate with another company, both would benefit fairly)*. A mean openness to external sources score was computed for each of the respondents, using the sum of the mean responses to three statements which loaded strongly together (factor loading >0.65). This was divided into tertiles (of low, medium and high) and used for further analysis.

[10] Kaiser-Meyer-Olkin measure of sampling adequacy (KMO): "represents the ratio of the squared correlations between variables to the squared partial correlation between variables. It varies between 0 and 1: a value of 0 indicates that the sum of partial correlations is large relative to the sum of correlations, indicating diffusion in the pattern of correlations. Hence, factor analysis is likely to be inappropriate. A value close to 1 indicates that patterns of correlations are relatively compact and so factor analysis should yield distinct and reliable factors" (Field, 2009:788).

[11] Barlett's test of sphericity: "examines whether a variance-covariance matrix is proportional to an identity matrix. Therefore, it effectively tests whether the diagonal elements of the variance-covariance matrix are equal, and that the off-diagonal elements are approximately zero (i.e. the dependent variables are not correlated)" (Field, 2009:782)

Table 5.3: Absorptive Capacity Measure 1 (M1) –factor loadings of questions assessing receptivity to external sources of innovation (with both 4 and 5 questions) and mean with standard deviation (SD) of the total respondent sample

	Loading with all five items	Loading with four items	Mean	SD
Component 1				
It is important for your company to develop a network of contacts in academia	0.81	0.80	3.51	0.82
Developing contacts in support agencies is relevant to your company	0.71	0.72	4.09	0.78
Ongoing publicly-funded research has significant potential application for your company	0.62	0.65	3.38	1.00
If your company was to collaborate with another company, both would benefit fairly	0.37		3.48	0.88
	Cronbach alpha: 0.41	Inter-item correlation mean: 3.42		
Component 2				
The best sources of innovative ideas is from within your company (*reversed prior to analysis*)	0.71	0.92	3.31	0.99
If your company was to collaborate with another company, both would benefit fairly	0.51		3.38	1.00
	Cronbach alpha: 0.54	Inter-item correlation mean: 3.66		

In order to ascertain the perceived value placed on different levels of external sources of innovation (M2), respondents were asked the extent to which they agreed that a number of different organisations were of use in company technological innovation activities (on a five point Likert scale with 1=*strongly disagree* and 5=*strongly agree*). Only companies who indicated they had engaged in technological innovation in the last three years were asked to complete this section (*n*=96). PCA using direct oblimin rotation was conducted and sources loaded onto two components (table 5.4). The components were named *commercial* and *public sector*. As suggested by Schmidt (2010), the information available from public sector sources was taken to have a higher level of complexity, and those who found it useful were assumed to have a higher level of absorptive capacity. Surprisingly, in spite of the commercial focus of consultants they loaded strongly on the public sector component and were thus included in the same. This was justified by their role in supplying external support to companies, similar to the other organisation grouped as public sector.

Table 5.4: Absorptive Capacity Measure 2 (M2) –factor loadings of commercial and public sector components and mean with standard deviation (SD) of the total respondent sample

	Factor Loading	**Mean**	**SD**
Component 1: Commercial			
Competitors	0.74	3.50	0.98
Customers/retailers	0.69	4.11	0.91
Suppliers	0.60	3.43	0.97
	Cronbach alpha: 0.51	Inter-item correlation mean:3.68	
Component 2: Public sector			
Teagasc	0.80	2.97	1.14
Industry Support Groups e.g. ISME	0.79	2.68	1.13
Country Enterprise Ireland	0.76	2.55	1.01
Bord Bia	0.68	3.41	1.01
Enterprise Ireland	0.58	3.71	0.97
Consultants	0.55	2.23	0.92
Universities/3rd level institutes	0.51	3.10	1.05
	Cronbach alpha: 0.81	Inter-item correlation mean: 2.93	

When three clusters were specified using K-means cluster analysis, the groups emerged as follows:

1) Companies that did not find external sources of information useful (M2: lowest level)
2) Companies that found commercial sources of information useful (M2: middle level)
3) Companies that found both commercial and public sector sources of information useful (M2: highest level).

Due to the removal of 'non-innovators' from M2, a slight skewing of results was seen (see Chapter 7).

5.6.7.2 Independent variables

In order to facilitate discussion of the independent variables from the model, the modified matrix is presented in figure 5.4 (numbered according to the following discussion). The conceptual development of this modified version of the Lane *et al.*

(2006) model, building on the first round of semi-structured interviews, is presented in Chapter 5.

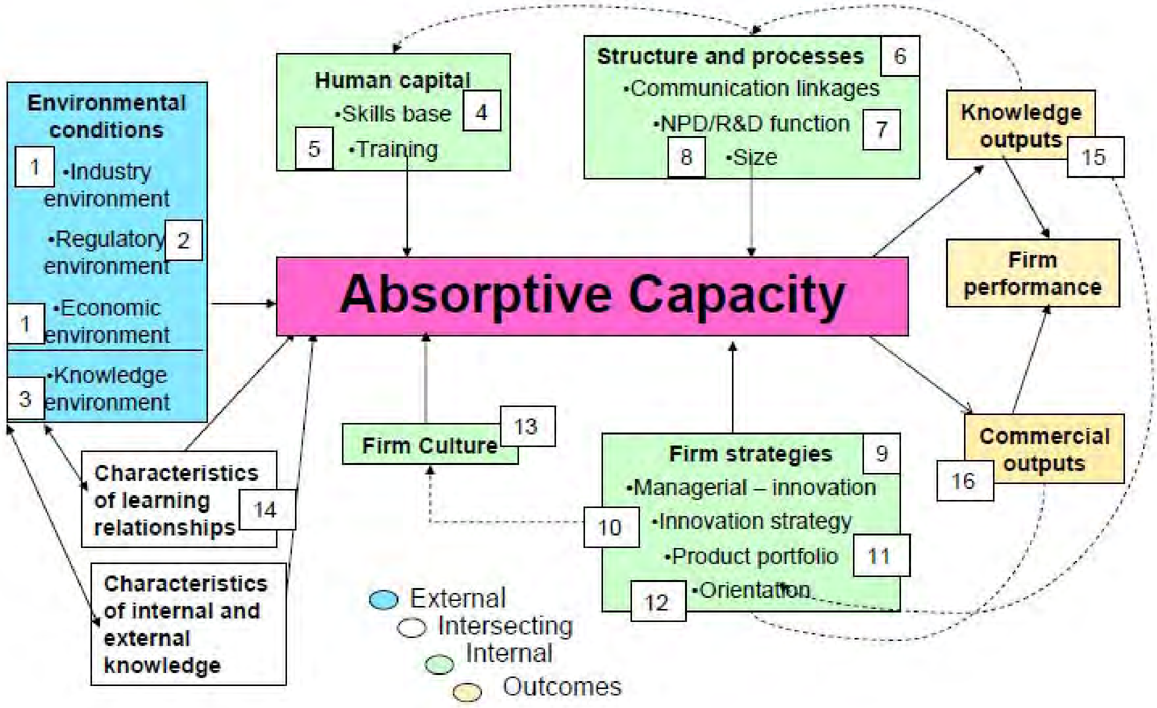


Figure 5.4 Framework for investigating the uptake of technological innovations from sources external to a company

5.6.7.2.1 External factors

<u>*Industry and economic environment (Figure 5.4, No. 1)*</u>

Subjects were asked to indicate how strongly a selection of 13 items impacted on company innovation activities by rating the items on the following scale: *None-1, Some-2, Some-3, A lot-4, A lot-5.* Prior to performing PCA, the suitability of the data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients above 0.3, as recommended by Pallant (2007). The Kaiser-Meyer-Olkin value was 0.83, exceeding the value of 0.6 recommended by Kaiser (1970). The Bartlett's Test of Sphericity (Bartlett, 1954) also reached statistical significance, supporting the factorability of the correlation matrix.

The items were factor analysed, using PCA, with direct oblimin rotation. All but one variable loaded strongly and clearly on one factor. The variable that loaded on two factors was removed, and factor analysis was re-run with the remaining variables. An inspection of the scree plot revealed a clear break after the third component. Using Catell's (1966) scree test, it was decided to retain three components for further investigation. Table 5.5 summarises the factors analysis performed on the 13-item scale. Three factors accounted for 63.3% of the variance.

Table 5.5: Loadings as per factor analysis of external factors

	Loading	**Mean**	**Standard Deviation**
Impact of the following items on innovation:			
Factor 1 – Operating Environment			
Energy costs	0.90	2.69	1.33
Wages bill	0.89	2.95	1.33
Waste charges	0.86	2.57	1.34
Exchange rates	0.45	2.84	1.50
			Cronbach alpha: 0.85
Factor 2 – Competitive Environment			
Consumer trends	0.80	3.36	1.32
Suppliers	0.73	3.56	1.11
Retailers	0.70	2.39	1.15
Competitors	0.68	3.12	1.06
			Cronbach alpha: 0.73
Factor 3- Economic Environment			
State grants	0.85	3.38	1.28
Tax incentives	0.81	2.72	1.45
Availability of credit	0.73	2.28	1.39
State of the economy	0.63	2.79	1.43
			Cronbach alpha: 0.80

Factor 1 consisted of four variables associated with the operating environment of the firm and was labelled *operating environment*. Factor 2 was composed of four variables, which are elements of Porter's five competitive forces model, and was labelled *competitive environment*. These two factors combine to create the industry factor depicted on the absorptive capacity framework (see figure 5.4, No. 1). The final factor had four variables, which relate to the current economic climate and government fiscal measures, and was thus termed *economic environment*. For each company, a mean of responses to each of the three factors was computed and used for further analysis.

Regulatory environment (Figure 5.4, Number 2)

In order to understand the perception of the current regulatory environment facing Irish food SMEs, respondents were asked to indicate which of eight regulations impacted on their company's innovation activities. In order to ensure sufficient numbers in each group to enable meaningful analysis, responses were grouped into tertiles as follows: 1) 0-3 ticked, 2) 4-5 ticked, 3) 6-8 ticked. The breakdown of responses is documented in table 5.6.

Table 5.6: Perception of the level of regulation that must be adhered to in a sample of Irish food companies

	***n* (%)**
None (0-3)	49 (41.9)
Some (4-5)	39 (33.3)
Many (6-8)	30 (25.6)

Knowledge environment (Figure 5.4, Number 3)

The perceived relevance of the knowledge environment was ascertained by asking respondents about the extent to which they agreed that a number of different organisations were of use in company technological innovation activities (on a five point Likert scale with 1=*strongly disagree* and 5=*strongly agree*). As described above in M2, only companies who indicated they had engaged in technological innovation in the last three years were asked to complete this section (n=89). When factor analysis, using direct oblimin rotation was conducted, the two emerging components were named as: 1) *commercial* and 2) *public sector.* In this instance, 'K-means clustering' of the factors produced from the PCA was conducted, specifying two clusters using factor analysis scores. When two clusters were specified, the two groups which emerged were as follows: 1) companies which indicated a low usage for both *commercial* and *public sector* sources of innovation (*low use*) and 2) companies which indicated a high usage of both types of external sources of innovation (*high use*). The loadings are presented in table 5.7.

Table 5.7 K-means clustering of the usefulness of external sources of innovation, with two clusters for a sample of Irish food companies

	Low use (*n*=35)	**High use (*n*=54)**
Non-Corporate	-0.90	0.59
Corporate	-0.63	0.41

5.6.9.2.2 Internal factors

Mental models

In the absorptive capacity framework, the factors of interest in relation to internal mental models are two-fold: skills base and training.

Skills base (Figure 5.4, Number 4)

To establish the level of the skills base present in each firm, respondents were asked to indicate the highest level of qualification of personnel involved in the NPD function from five different options: *Secondary School, 3rd Level Certification/Diploma, Degree, Masters,* and *PhD.* A number of firms that did not indicate that they had a NPD function did specify the highest level of qualification within the firm. As the study was interested in the effect of the level of educational qualification on innovation occurrence within the company, as had been investigated in previous studies (Romijn and Albaladejo, 2002; Avaermate *et al*, 2004), these were included in further analysis. In order to ensure there were sufficient respondents in each group to make comparisons, secondary school and diploma were merged into one group, as were PhD and Masters. There were sufficient employees with degrees to form a separate group.

Training (Figure 5.4 – Number 5)

In order to establish the level of investment in training by food companies, respondents were asked "how much, on average over the last three years was spent directly on staff training by your company annually?" Following assessment for outliers, three respondents were found to extend more than three box-lengths from the edge of the box plot, indicating extreme outliers. These figures were re-checked with the original questionnaires and found to be accurately reported. Although it is possible that the respondents misunderstood the question, all three had indicated 'employee' and 'turnover' superseding SME classifications and it is possible that true figures were reported. However, due to the extreme skewing caused by the three figures, each was replaced with a missing value for further analysis. Details of the training spend are provided in table 5.8.

Table 5.8 Reported training expenditure in a sample of Irish food companies

	With outliers	**Without outliers**
Mean	€37,157	€28,297
5% Trimmed Mean	€28,125	€25,441
Std. Deviation	€64,235	€33,916
Minimum	€0	€0
Maximum	€500,000	€120,000
Skewness	4.66	1.44
Kurtosis	29.72	0.77

The symmetry of the data (with and without outliers) was tested by assessing the level of skew. The positive skew (4.66 and 1.44 respectively) indicted a clustering to the lower end of the values for both tests; however, the removal of the outliers caused a reduction in skew. When the level of kurtosis was tested for the data, the removal of the outliers caused a flattening (0.77) of the previously peaked distribution (29.72). The actual number of employees in eighty-four of the companies was established through internet searching (company website and internet search) and direct contact. The per capita training spend was then established for each of these companies.

Structures (Communication Linkages) (Figure 5.4, Number 6)

In order to establish a measure for the structures in place in firms to facilitate internal communication, respondents were asked to indicate which of six communication linkages were in place (cross-functional teams, internal messaging system, regular cross-company informal events, mentoring and coaching for new employees, internal database for idea sharing, job rotation for new employees; drawn from Anderson, 2008; Cooper *et al.*, 2004; Cormican and Sullivan, 2004; Roupas, 2008). Companies were then grouped into two categories, depending on how many structures for communication were present, as follows: 0 -2 *poor*, 3-6 = *good*. When broken down in this way, the two groups were reasonably homogeneous in size. The breakdown of companies with varying levels of communication linkages is presented in table 5.9.

Table 5.9: Prevalence of varying levels of open communication linkages in a sample of Irish food companies

	***n* (%)**
Poor (0-2 linkages)	49 (38.5)
Good (3-6 linkages)	78 (61.4)

NPD function (Figure 5.4, Number 7)

Another element of the company, which facilitates innovation, is the NPD function. Respondents were asked whether their company had a dedicated NPD/R&D function. Further details on staffing levels and facilities (*e.g.* kitchen/laboratory/pilot plant/other) were also determined.

In order to differentiate the level of R&D present in companies, two proxy indicators were used. Firstly, companies were asked whether they had availed of Enterprise Ireland grants for R&D in the last three years. For Enterprise Ireland to award a grant, a certain level of R&D capability is required and companies must have greater than ten employees (Enterprise Ireland, 2010a[12]). Secondly, respondents were asked to indicate if they had availed of the R&D tax credit in the last three years. R&D tax credits[13] are subject to a number of preconditions and stipulations, which must be satisfied before they are granted (Revenue Commissioners, Ireland, 2010).

Furthermore, companies were asked to provide an estimate of total spend on R&D. On assessment for outliers, four responses were deemed inadmissible, as they extended more than three box-lengths from the edge of the boxplot and were classified as extreme outliers. Such figures were replaced with missing values for further analysis (see table 5.10). The removal of the outliers resulted in reductions in skew and peakedness (see table 5.10). Similar to the training spend, for companies in which the actual number of employees was known, R&D spend per capita was established.

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[12] Enterprise Ireland (2010a) Funding: Supports and Programmes. [online] Available at: http://www.enterprise-ireland.com/en/funding-supports/Company/Esetablish-SME-Funding/R-D-Fund-Small-Projects-.html [Accessed 02/01/2011]

[13] Revenue (2011) Companies can apply for a 25% tax credit for qualifying Research and Development expenditure within the European Economic Area. Regulations stipulating the activities which constitute R&D are provided by the Department of Enterprise, Trade and Employment. www.revenue.ie/en/**tax**/ct/leaflets/research-dev.pdf [Accessed 02/01/2011]

Table 5.10: Expenditure on, and number of, employee involved in research and development in a sample of Irish food companies

	R&D spend		**Full time**	**Part time**
	With outliers	**Without outliers**	**Employee number**	
Mean	€289,429	€165,323	4	1
5% Trimmed Mean	€241,881	€152,160	3	1
Std. Deviation	€385,039	€176,573	5.25	1.3
Minimum	€2,000	€2,000	0	0
Maximum	€1,500,000	€600,000	30	6
Skewness	1.88	1.05	2.7	1.6
Kurtosis	2.96	-0.72	9.1	3.5
Kolmogorov-Smirnov	.000	.000	.000	.000

Size (Figure 5.4, Number 8)

To categorise size, companies were classified using the EC definition of company size regarding turnover and employee number. The small and medium-sized enterprise classification was expanded into three sections to allow for more in-depth analysis (employee number: 10-49, 50-99, 100-250 employees; turnover: €2-9.9 Mn, €10-19.9 Mn, and €20-49.9 Mn).

Management involvement (Figure 5.4, Number 9)

To order to investigate the level of managerial involvement in NPD, respondents were asked to indicate the level to which they agreed with the following statement: “Senior managers are always directly involved in new product development” (Possible range of responses: 1 to 5, where 1 is *disagree strongly* and 5 is *agree strongly*).

Firm Strategies – Innovation (Figure 5.4, Number10)

In order to establish the prevalence of formal innovation strategies in food companies, respondents were asked to give specific details as to the formal strategies in place in the company. Respondents who replied positively to the presence of a formal strategy were coded ‘1’, while negative responses were coded ‘2’ and non-response as

‘0’. As an open-question format was used for this question, responses were individually coded manually, following data collection. Respondents who indicated that they had a formal strategy for the following items were coded appropriately: innovation, NPD, lean manufacturing, staff development and consumer-orientation. It was important to take into consideration, when analysing the data, which the question regarding the presence of formal strategies in the company was in an open-ended format, as opposed to the closed-ended format of the rest of the questions discussed.

Product Portfolio (Figure 5.4, Number 11)

In an attempt to identify the companies which valued product portfolio compatibility, respondents were asked to indicate whether “compatible with the current product portfolio of the company” was among the top three requirements when investing in developing a technological innovation. Positive responses were coded ‘1’, non-responses were coded ‘0’.

Orientation (Figure 5.4, Number 12)

Company orientation was assessed by asking respondents to indicate the activities of the company from the following option list: *branded goods only, private label goods only, mixture of branded and private label*, and *non-applicable*. Traill and Grunert (1997) identified three possible orientations for food companies: product, process and market. They contended that companies which focus on branded goods tend to be product-orientated, and companies primarily engaged in manufacturing private label goods are orientated towards process. To give an indication of which companies were market-orientated, respondents to this survey were asked to specify whether they conducted market research. The responses of companies are presented in table 5.11.

Table 5.11: Prevalence of different types of orientation (product, process or market) in a sample of Irish food companies

	***n* (%)**
Product orientated (Branded goods only)	9 (7.1)
Process orientated (Private label goods only)	86 (67.1)
Mixture of branded and private label	11(8.7)
Not applicable	17 (13.4)
Conducts market research (Market orientated)	90 (70.9)

Due to the vast majority of companies which indicated they were involved in a mixture of branded and private label goods, this method of classifying companies was not deemed to be particularly useful for further analysis. The high number who indicated they engaged in market research further exacerbated this. In addition, groups were not mutually exclusive and could not be compared directly. As a result, classifying companies by orientation using this method was not pursued.

Firm Culture (Figure 5.4, Number 13)

In order to develop a measure for company culture, respondents were asked to endorse the statement “In the company I work for…” for each of nine items by choosing between five responses: *disagree strongly, disagree, neutral, agree, and strongly agree,* scored 1-to-5 [based on previous studies (Hofstede, 1980; Zien and Buckler 1997; Buch and Rivers, 2001; O’Regan *et al,* 2006; Taras *et al.,* 2009)]. Items which were phrased negatively were reversed prior to further analysis. The items were factor analysed with direct oblimin. All variables loaded strongly and clearly on one factor. Table 5.12 summarises the factor analysis performed on the 9-item scale. Two factors accounted for 51.97% of the variance. Factor 1 was composed of six variables relating to a positive firm culture and was labelled *positive culture*. Factor 2 consisted of three factors, which could be associated with a negative firm culture, and this was termed *negative culture*. The loadings for the two factors are presented in table 5.12. For each company, following a reversal of the negatively scored questions, a mean response for culture was computed and used for further analysis.

Table 5.12: Loading as per factor analysis of firm culture scale

	Loading	**Mean**	**Standard Deviation**
In the company I work for:			
Factor 1 – Positive Environment			
There is a supportive environment for innovation	0.778	3.78	0.82
Resources (time/money) are allocated for creative work	0.741	3.52	0.98
Innovation is written into the mission statement	0.686	3.45	1.13
Employees of all levels are involved in idea generation	0.626	3.09	1.06
Employees of all levels are rewarded for good performance	0.620	3.55	0.90
Employees engage readily in team work	0.583	3.68	0.82
		cronbach α =0.75	
Factor 2 – Negative Environment (reversed)			
Employees like to maintain the *status quo* with regards to products and processes	0.744	3.25	1.01
Change is difficult to implement	0.709	3.23	1.20
The unions have a strong input into employee practices and procedures	0.682	2.38	1.27
		cronbach α =0.56	
		inter-item correlation mean= 3.06	

5.6.7.2.3 Intersecting factors

Characteristics of the learning relationship (Figure 5.4, Number 14)

To investigate the perception of the quality of relationships between companies and organisations providing innovation ideas or knowledge, respondents were asked to indicate the level to which they agreed with the following statement: “If the company was to collaborate with another company, both would benefit fairly” (Possible range of responses: 1 to 5, where 1 is *disagree strongly* and 5 is *agree strongly*).

Characteristics of internal and external knowledge

This variable was not measured within the scope of the questionnaire, as it had been previously investigated by a project based in the Teagasc Research Centre, Ashtown. However, in order to give a comprehensive overview of the area within this project, this topic was followed-up in the third stage of research and is detailed in the Chapter Eight.

5.6.7.2.4 Outcomes

Knowledge outputs (Figure 5.4, Number 15)

To gain an understanding on the importance placed on developing knowledge outputs within a firm, respondents were asked whether *developing the understanding of the area within the company* was one of the three most important factors when deciding to invest in a technological innovation from a pre-defined list of eleven options. Positive responses were coded '1', negative responses were coded '0'. Respondents who had indicated more than three options were excluded from analysis. Only 3.1% (n=4) chose this option as one of the top three motivations to invest in a technology.

Commercial outputs (Figure 5.4, Number 16)

The importance placed on commercial outputs was ascertained using two questions. The first asked companies to choose the top three reasons for investing in a new technology from a list of eleven items. The two options relating to commercial outputs scored highly. A further question asking respondents to indicate the level of priority assigned to a list of nine outcome options was also posed.

The results of the analysis of the questionnaire are discussed in Chapter 6.

5.7 Primary research: Follow-up interviews with industry and research representatives

As suggested by Miles and Huberman (1994), this stage was conducted in order to enhance the understanding of the results from the earlier steps in the research process.

5.7.1 Data collection instrument

A semi-structured format of interviewing (as described in section 5.5.1) was used to conduct the follow-up interviews. The topics covered in the interview guide arose from the results of the questionnaire, and are presented at the end of Chapter Seven. Although open-ended questions were again used to ensure the flow of conversation, the questions featured were more directive than before. Some differences existed between the interview guide that was used for the industry and non-industry representatives (see Appendix IX and X). Similar to the interview guide for the first round of interviews, the one for industry involved some company-specific aspects (*e.g.* examples of research projects that were ongoing in the company). Contrastingly, the support-agency guide was more general in nature, usually addressing a specific sector as opposed to a specific company.

5.7.2 Sampling framework

As particular issues were of interest at this stage, purposive sampling was again used to select the participants. A number of selection criteria were employed when choosing potential interviewees, as follows:

1. *Geographical location - Outside Leinster:* the first round of interviews was limited to Dublin and surrounding region. Therefore, a number of interviewees outside this area were targeted in this round.
2. *Manufacturing base in Ireland*: as before
3. *Companies who had not responded to the questionnaire*: this was to ensure companies were not over-burdened
4. *Innovative companies/involved with innovation in companies*: as the issues of interest were specific to innovation, respondents were required to be involved in

innovation activities and possess a knowledge of this field. In order to ascertain this, an internet search was undertaken in which prior or current involvement in collaborative projects between industry and research providers was assessed.

Potential interviewees were contacted initially by letter (see Appendix XI) and then followed-up with by phone and e-mail. All but one of the targeted interviewees took part in the interviews.

5.7.3 Data collection and analysis

In total, five interviews adhering to the interview guide and five interviews which focused on specific parts of the guide were conducted. The focused interviews arose due to the time constraints on interviewees; in such cases, the conversation centred on the issues in the guide, but not all topics were discussed. The full interviews lasted between 45 minutes and one hour; the focused interview ranged from 20-30 minutes. All interviews took place in the workplace of the interviewee. All were recorded using an Olympus WS200-S Voice Recorder. A contact summary sheet was completed by the interviewer after each interview, in which the key emerging themes and reflections of the interviewer were noted (see Appendix IV). Interviews were reviewed and emerging themes catalogued. Selected quotes from the interviews were transcribed *verbatim* by the same researcher. Results of the final stage of interviews are discussed in Chapter 8.

5.8 LIMITATIONS OF THE STUDY

Despite the strengths of the research methodology and the strict procedure which resulted in an impressive response rate to the survey, there are a number of limitations to the study. Due to the broad nature of the survey, the number of initial and follow up interviews, could be deemed too few for full qualitative exploration of the survey findings.

Furthermore, by asking respondents to report whether their company had engaged in innovation in the last three years, the survey was open to subjective bias: the term innovation can be interpreted in numerous different ways (Schumpeter, 1950; Rogers 1962; Knight, 1967; Porter, 1990). However, given that the overarching aim of this research was to identify ways and means of facilitating innovation in Irish food SMEs, it was felt that it was the opinion of the company as to whether they had engaged in innovation that was of particular relevance. Indeed, Rogers (1962) believed that it was the relative interpretation which was of importance when identifying an innovation and that any idea that is perceived new to the user should be taken to be an innovation.

Given the remit of the project's funding, this research focused primarily on technological innovation levels in Irish food SMEs. However, as discussed in the literature section, the importance and relevance of organisation innovation to the cohort warrants a mention and may be of particular interest in future research

5.9 CONCLUSION

This chapter attempted to justify the decision to follow a mixed method approach to this research. In addition, it described the procedure for conducting the three stages of research. The following chapter details the conceptual development of the framework and hypotheses for investigating the research question.

Chapter 6

Methodology 2 - Conceptual development of research framework

6.1 INTRODUCTION

Initial review of relevant literature resulted in the selection of the Lane and colleagues (2006) model as a starting point for the investigation of technological innovation in Irish food companies. However, several biases were found to exist in the literature, including a focus on high technology industries and large firms. Consequently, a number of semi-structured interviews with representatives from industry and government support agencies were conducted with a view to reconciling the literature within the context of the predominantly low-tech Irish food industry, in which the majority of companies are SMEs. In doing so, the limitations of the original model could be investigated to ensure it provided a comprehensive picture of the area under study. In addition, these interviews enabled the precise orientation of future quantitative work by contextualising the elements of the model, and ensuring the terminology was relevant, to the food industry. This chapter presents a synthesis of the outcomes from the semi-structured interviews and the relevant existing literature, illustrated as a revised model. The testing of the component parts of this modified model formed the basis of the hypotheses which were investigated in the next stages of the research. Due to previous work in Teagasc and DIT on the intersecting aspects of the model (Henchion *et al., In press* A, B; Henchion et al., 2008; Kelly *et al.,* 2008) these were not included in the discussion topics covered.

6.2 EXTERNAL DRIVERS

6.2.1 Environmental conditions

As demonstrated in the following sections, the evidence from the semi-structured interviews reaffirmed the belief that the external business environment is very influential for company activities (Cohen and Levinthal, 1990; Todorova and Durisin, 2007; Zahra and George, 2002).

6.2.2 Economic environment

The impact of the economic environment, and the resultant availability of finance, is an important consideration when examining technological innovation. This factor was not specifically included in Lane's (2006) suggested external factors; however, the current economic climate was an area of concern highlighted by all interviewees. Reduced consumer spending power, coupled with cross-border trade due to exchange rate variations, were cited as particularly detrimental factors for Republic of Ireland (ROI) food firms, with both factors translating into decreased sales and profit margin. However, interviewees contended that innovative product offerings, and cost-cutting measures which can facilitate a price reduction, create potential for a restoration of sales and profit margin. A representative from the support-agencies detailed how government-sponsored initiatives to support companies in identifying areas for possible competitive advantage were advocating strategic operating cost reductions (often involving "lean" manufacturing practices). However, interviewees expressed apprehension that the considerable reductions ("cutting back on everything") will result in there being "nothing there when the upturn comes", with one interviewee warning that staff reduction, as a means of short-term cost-cutting, may impact adversely on longer term issues relating to innovation, due to the reduction in available human capital. A perceived positive outcome from the economic downturn, cited by interviewees, was an increased ease of change implementation within firms, as employees now acknowledged a rapidly evolving economic climate and the need for flexibility for survival:

> *They all [the employees] saw what was happening out in the market place. So! I think certainly we have changed hugely in here. Over the years it was very unionised and it was difficult to get anything through. Whereas now, I would imagine, the majority of our employees see that what we are doing now is for their benefit. And [they] realise that, any changes we are making [is so] we can keep the manufacturing [here in Ireland]. (Firm 3, NPD manager)*

In conclusion, the short-term challenge posed by a difficult economic environment may be offset by greater receptivity to new business practices, which may impact favourably on the company over the longer term. Thus, the economic environment is an important consideration and warrants inclusion in the model.

6.2.3 Industry environment

In Porter's (1985) Five Competitive Forces model, he outlined how industry structure determined the degree to which factors such as suppliers, potential market entrants, buyers, substitutes[14] and industry competitors' impact on a firm's ability to be sustainable. The results of this study reaffirmed that competition is driving the research agenda in SMEs. This has resulted in an increased drive for NPD, in addition to inspiring innovative ways of reducing costs through modifying manufacturing processes, organisational structures, and work practices:

> *We can't just churn out more and more [product] and try and compete against those guys [MNCs], because it just doesn't work. They are too big. So! That's what drives the need to bring in new technologies, and new ways of doing things: trying to be ahead of those guys a little bit. (NPD manager, Firm 1)*

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[14] Substitutes refer to the ease that a product can be substituted with another; this depends on the costs and inconvenience of such a swith (Porter, 1985).

Interviews highlighted the difficulties of retaining and growing market share when competing against MNCs with greater economies of scale. International MNCs may also be operating in countries with a lower cost base than that in Ireland, which facilitates lower prices, again increasing pressure on Irish food SMEs. As a result, in order to justify the retail price premium, companies felt they needed to be innovative and produce "something different", as opposed to competing in terms of cost:

> *Keep pumping out the NPD. You have got to be different to charge a premium. You are not going to beat [greater economies of scale]. Obviously, you are going to have to try [to] lower your costs as much, but the chances are, with a plant in the UK producing twenty times the volume, they are going to have lower cost per unit. So! You are just going to have to try and justify the premium, and you do that by innovation. (Support agency representative 2)*

This finding is particularly pertinent to the food sector in Ireland due to the high proportion of SMEs. Perceived high costs relating to energy, raw materials and wages were cited as specific concerns, and have been exacerbated by a weak Sterling. Such specific concerns were noted for the next stage of the research. The impact of retailer leverage on company innovation activities was also cited by interviewees as a salient issue:

> *The other big threat was [a multiple], which affected a lot of Irish manufacturers. [They] brought in their UK 'planograms'*[15] *and took the space out of a lot of Irish companies. (Firm 3, NPD manager)*

> *Like when you are doing own brand stuff for supermarkets: they own the brand, they own the product and you are a sub-contractor, and they will drop you as soon as they will take you up. You have no power whatsoever. (MD, Firm 2)*

Relationship development with retailers was articulated to be integral to increased market penetration, but was considered by some to be achieved at a high cost (price promotions and unfavourable conditions of supply), thereby representing a significant burden to Irish food SMEs:

[15] Planograms = schematics

And then of course retailers want promotions…They [the retailers] look at their product range every six months. If it looks that one particular brand isn't driving anything in the category, then they are going to be taken out. (Support agency representative 2)

You saw it even in today's news. [A multiple] are looking for half-a-million off [sic] suppliers before they even put the products on the shelf - or to keep it on the shelf. (NPD manager, Firm 2)

Interviewees explicitly expressed a feeling of powerlessness in the face of this extensive control, and feared for possible repercussions if concerns were voiced:

So long as supermarkets don't have to publish figures, you haven't a clue what kind of margins they are making, and individual companies are, for obvious reasons, reluctant to take them [retailers] on. They can't because it's guaranteed suicide. (MD, Firm 2)

It was concluded that a combined pressure from competitors and retailers, while driving innovation, could also stifle it through reducing available resources, and creating constant uncertainty of revenue streams and a negative environment for risk taking.

6.2.4 Regulatory environment

The restrictive effect of EU food legislation on innovation and development has been highlighted in the literature, with both the Novel Foods and Novel Ingredients (EC258/97) and Health and Nutrition Claims regulations (EC1924/2006) being of particular importance (Anonymous, 2009b; Coopens *et al.,* 2006; Hermann, 2009). Respondents demonstrated an explicit awareness of this legislation; however, this was tempered with a wariness of the expense and bureaucracy involved in submitting ingredients for approval.

To support them you have to do extensive research, extensive research costs a lot of money and you don't have that money in the food industry. (MD, Firm 2)

One interviewee cited the recent precedent involving rejection of product health claims by the European Food Safety Authority as a specific area of concern.

Danone were being told, was it their probiotics [claims]? Were actually being thrown out…They couldn't make the health claims…So I think they have re-lodged some papers recently to try [again] and that is costing an awful lot of money. (MD, Firm 2).

Comments from a non-industry interview indicated that for those involved in this area, legislation could be "driving" innovation and creating "a level playing field". However, this was in contrast to a number of the industry interviewees who questioned the immediate relevance to their company's products, processes and packaging, due to high-perceived investment costs of advanced technological development versus the low margin nature of the food business. Taken on face value, such findings indicate a short-term development perspective among Irish food SMEs, at odds with the typical development timelines of radical innovative technological development. However, it appeared that such a strategy was borne out of a reasoned understanding of the cost of innovation and the perception of an uncertain EU regulatory climate.

Such results also signal the possible emergence of a two-tier system, in which only larger food companies will have the resources to pursue this avenue of new product development based on technological innovation. A suspicion also articulated by some respondents that there was an element of uncertainty regarding the specific requirements of the legislation, which especially represented a high risk proposition for small start-up enterprises. Interestingly, similar to findings by Massoud *et al.* (2010) and Cantillon *et al.* (2005), the food legislation which was found to be a top-of-mind issue for interviewees, related mainly to food safety requirements. This was thought to affect all companies equally, and was not deemed a barrier to innovation.

6.2.5 Knowledge environment

The modern knowledge environment stresses the integration of publicly and privately-funded sources of knowledge in supporting the innovation process (Lane *et al*, 2006). The benefits of open innovation systems (Chesbrough, 2003), defined by recognising the importance of external knowledge sources, is a major theme in recent innovation literature (Chesbrough *et al.,* 2008). The value of such systems extends beyond fast growing technology-intensive industries (such as computer chip development) to more traditional sectors, such as food (Avermaete, 2004). Although recognised by the support agency interviewees as hugely valuable, industry respondents expressed hesitance about engaging in open innovation processes. Stated fears revolved around possible compromise of competitive intelligence and IP rights, and perceived poor return on investment:

> *I don't know how open people are going to be in front of other companies, to be honest with you, (be)cause [sic] I wouldn't have the freedom to go and discuss, like, very new innovations with other companies. Really, I wouldn't. (NPD manager, Firm 1)*

This apparent low engagement may be as a result of a lack of awareness of the potential of the open innovation philosophy, a possibility mentioned by one interviewee. However, uncertainty about confidentially and IP protection may also be motivating the hesitance to engage in such practices. However, it may alternatively be indicative of entrenchment in their existing innovation practices, which traditionally focused on internal capabilities (Chesbrough, 2003). Attempts to minimise risk in an uncertain market may have resulted in the strategic decision to follow the existing conventional business models. This has implications for those engaging in efforts to support innovation in companies and warrants further investigation.

6.3 INTERNAL DRIVERS - GENERAL

Factors internal to the firm are integral to the concept of absorptive capacity: the internal bedrock of knowledge, residing in the employees of the firm and in the processes of knowledge-sharing, influences the ability to recognise, assimilate and apply, valuable external knowledge (Cohen and Levinthal, 1990).

6.3.1 Mental models

Human capital is the stock of knowledge and training skills present within the company (Wagner, 2003). In a study of food companies, Avermaete *et al* (2004) reported a correlation between the innovative capacity of a firm and the qualifications of its employees, concurring with results of studies from other industries (Koc 2007; Romijn and Albaladejo, 2002). In the current study, some interviewees highlighted the importance of tacit issues (*e.g.* inter-personal skills, strategic thinking, knowledge of the business and the relevant market, ability to read consumer trends, ability to develop relationships with customers, professionalism, credibility), citing an ability to "think strategically" and have "credibility to deal with customers" as more important attributes than formal qualifications *per se*; others felt that industry did not recognise the importance and benefit of highly-qualified staff. Low profit margins, which may necessitate low wage rates, were also suggested as a contributing factor to the poor uptake of postgraduates by the industry.

The benefits of training to innovation capacity is a contentious point in the literature, with reports of positive influence (Avermaete *et al.*, 2004) vying with misgivings related to the focus of such training: the questionable value of management and administration courses as a support to strategic development of innovative capacity has been highlighted (Romijn and Albaladejo, 2002). In the current study, an interviewee from a support agency maintained that managerial training and development was a means of diffusing innovative practices throughout the entire company.

> *The transformational programmes are for top management … the only way you can affect permanent change is if it comes, if it happens at senior management, not one person. (Support agency representative 2)*

However, companies indicated that the majority of training expenditure funded the legally required food safety training, reinforcing the lack of focus on training that would benefit innovation within companies.

> *We need to do it [training] for BRC … so it is more from a standard point of view that we need to retrain everybody. (Firm 3, NPD manager)*
>
> *HACCP is one of the ones everyone needs to have (Firm 2, NPD manager)*

6.3.2 Structures and processes

Due to the dynamic nature of absorptive capacity, the importance of iterative examination of policies and processes that aid knowledge transfer, sharing and integration is paramount (Zahra and George, 2002). Interviewees discussed cross-functional teams with particular reference to new product development, mentioning input from technical staff, finance, operations, purchasing, marketing and sales:

> *I suppose NPD deals with everybody, so what we tend to do, say on projects, is have multi-disciplinary teams, even finance, actually, (be)cause [sic] of, you know, costing as well. So it does involve everyone, you know. If there is [sic] process changes we need to have operations people on board. So generally it is all multi-disciplinary (Firm 3, NPD manager)*

Increased success rate in scale-up, when engineering was involved in NPD, was cited as a specific benefit of knowledge-sharing mechanisms. However, a *caveat* to this was that such cross-functional teams were thought to be more prevalent in larger companies. The more formalised nature of the cross-functional teams in larger companies may reduce their effectiveness if levels of bureaucracy, or lack of focus, impinge on effective idea sharing (Brockman *et al.*, 2010; Song *et al.*, 2011). Little further evidence of formal internal communication linkages in SMEs arose in the interviews. However, evidence of the use of a mediator or 'gatekeeper' (as described by Cohen and Levinthal, 1990) did emerge:

> *The [MD of company] is really the guy who brings a lot of those ideas in. That's the entrepreneurial streak in him. (NPD manager, Firm 1)*

The role of the MD in NPD is a controversial issue in the literature. Stewart-Knox and Mitchell (2003) stressed the importance of an MD concentrating on ensuring that day-to-day operations run efficiently, as opposed to focusing on long term projects (*e.g.* product innovation). Conversely, a number of studies have found direct involvement in NPD to be predictive of successful innovation (Kristiansen, 1998; Hoban, 1998). Due to this controversy, the importance of a managerial gatekeeper within the specific context of indigenous, SME, food manufacturing is worthy of further research.

6.3.3 Strategies

Strategy based on market insight plays a fundamental role in focusing value creation attempts (Lane *et al*., 2006), and many approaches based on marketing, technology development, product portfolio management and human capital development have been described. Recognition of the importance of innovation strategies was evident in some responses, often contextualised in terms of the competitive environment:

> *Part of our overall company strategy is…to be innovative, but to be perfectly honest with you, that's only in it because we are driven to be innovative, because we have to be to survive. (NPD Manager, Firm 1)*

Despite the presence of a strategy for innovation, idea generation through the enthusiasm of their managing director was believed to be a more effective way of inspiring innovations: "the (MD) is really the guy who brings in a lot of those ideas …he spots the opportunities". The belief that the value of an innovation strategy was mediated by the ethos inherent to the firm was prominent in a number of interviews. However, support agency respondents contended that this culture of innovation was absent in the majority of Irish food SMEs, and as a result there was a reduced potential for successful implementation of innovation management practices, and engagement in open innovation:

> *It's the issue around the culture of the company. How they look at innovation, and clearly innovation is not NPD or R&D or anything like that. It's how they operate. How they look for new ideas. How they bring them to market, and how they do it quickly and cost effectively. How they look outside and make use of other people's work for their own benefit. So I wouldn't classify the Irish food companies as very strong there. (Support agency representative 1)*

Influence of culture on the process of absorptive capacity was not referred to explicitly by Lane and colleagues (2006); however, such findings have been described in the food industry previously (Roupas, 2008). Therefore, this relationship may be significant in the context of the Irish food industry, and thus warrants attention in future work.

6.4 OUTCOME OF INNOVATION

Lane *et al.* (2006) reemphasised Cohen and Levinthal's original contention that the outcome of absorptive capacity should not solely focus on commercial deliverables, but also include knowledge outputs. IP protection, particularly in the form of patenting as a mode of commercial output, is actively promoted by government policies (for example, Department of Enterprise Trade and Employment, 2006; 2008). However, this means of conveying competitive advantage is not an activity traditionally pursued by the food industry (Hagedoorn, 2003). Indeed, interviewees opined that this arose from the lack of patentable work emerging from the majority of food SMEs:

> *There isn't a lot of new things happening, you know?. Your small Irish companies, no matter how big - they are still small on a world scale … Their ability to bring in new things is going to be very, very limited. (MD, Firm 2)*

> *Your average company isn't going to come up with something that is scientifically rigorous in most cases, and in many cases, in food, there is no culture of doing it [IP protection]. (Support agency representative 1)*

In addition to this, stated concerns in the interviews included the anticipated low return on investment, coupled with the low availability of resources in SMEs for pursuing IP protection. Furthermore, the perceived challenge involved in attaining IP protection, and the short product life-cycles of product innovations, were seen as barriers to patenting.

Despite these evident challenges, some interviewees opined that a continual drive towards IP management was ongoing within research institutes and large food companies, and this would be expected to filter down into smaller companies in the coming years. However, it is also possible that the more radical innovations, emerging from larger organisations, will continue to have a higher level of patentability in contrast to the innovations from smaller food companies which tend to be less so, due to their incremental nature. Respondents contended, however, that SME food companies did see more potential in developing competitive advantage through mechanisms such as secret know-how, process optimisation and technology in-licensing strategies:

> *But it's the know-how. It's how they get millions of pieces out the door. You could buy all the equipment tomorrow but you wouldn't be able to do it. It's a production process that's optimised. (Support agency representative 1)*

Further to this, development of brand equity, through trademarks and brand promotions, was cited as having a higher potential return on investment. When companies favour enhanced marketing of existing products, resources may be redirected away from R&D, resulting in reduced levels of technological innovation. Results from this study indicated that because patenting may not be utilised widely by food companies, focusing on this aspect of IP alone may give a distorted view of the true picture in the food industry. The results of the interviews suggested that competitive advantage, through other forms of IP protection, is being exploited extensively (for example secret know-how and trademarks). The incongruence between the occurrence of innovations and the numbers of patents attributed to low technology industries (such as the food industry) was investigated by NESTA (2007;2008) in their work on 'hidden' innovation. The ability of traditional measures of innovation (such as patent counts) to identify the innovations of most importance to such industries is an area worthy of further investigation.

6.5 MODIFICATIONS TO MODEL

In conclusion, although the model of Lane and colleagues (2006) provides an excellent overview of the absorptive capacity process and its influencing factors, a number of areas were highlighted by the qualitative interviews, which were of particular pertinence to examining technological innovation within the context of the Irish food industry. As a result of these issues, a number of modifications were made to the original model (figure 6.1). For ease of identification, colouring is used to differentiate external and internal drivers, intersecting factors and outcomes of innovation.

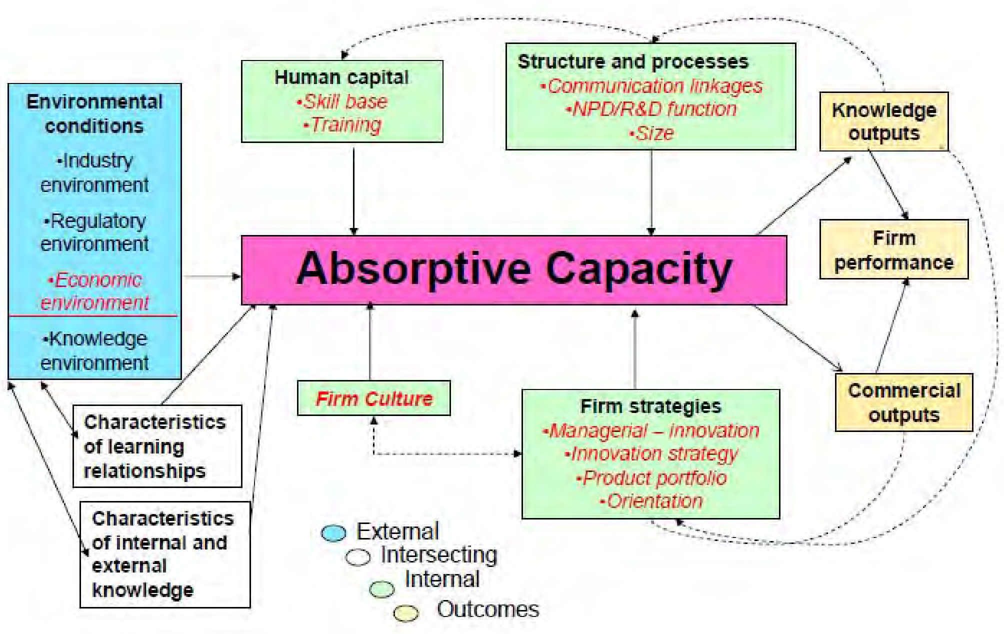

Figure 6.1. Proposed model of the influences on technological innovation in the Irish food industry. ***(Modified from Lane et al., 2006. Modified areas are highlighted in red italics)***

When accounting for the influence of the operational environment on absorptive capacity, the factors of interest include the industry, regulatory and knowledge environment (Lane *et al*., 2006). The above model has been expanded to illustrate such factors. In addition, the economic environment, which influences availability of credit and grants, is particularly significant when attempting to invest in capital-intensive ventures (for example, a new technology). The problem of limited funding is further compounded by restricted internal reserves, a feature of the low margin food industry, and by reduced sales and profits as consumers curb spending in times of economic downturn. Therefore, it is important to make allowances for the state of the economy when discussing technological innovation.

As mentioned above the intersecting factors did not form the focus of this thesis due to previous extensive work in the area.

In order to refine the model for the specific context of the Irish food industry, each of the internal factors was expanded to include the issues of particular interest. In addition, it was highlighted in the interviews that firm culture could be having a mediating effect on the implementation of innovation strategies. As a result, *firm culture* was added as an internal factor in the model. The prevalence of a poor innovative culture among Irish food SMEs could be impacting negatively on the potential for successful technological innovation, and therefore, warrants attention. However, innovation may be occurring in a non-formal or ‘hidden’ manner (NESTA, 2007) and this warrants investigation also.

In addition, terminology was found to be somewhat different in the food industry, compared to other industries, and this was taken into account in further stages (*e.g*. the “research and development department” was generally referred to as the “new product development department", although this also has implications for the level of R&D ongoing, and this was further investigated in the next step of the research).

6.6 HYPOTHESES

Building on the literature and the proposed refined model with inclusions based on the interviews with representatives' from the industry (as described in the preceding chapter), the following empirically testable hypotheses were developed.

H_1: Increasing awareness of the influence of the business environment drives engagement in innovation

- Increasing awareness of the competitive and operating environment drives engagement in innovation
- Increasing awareness of the economic environment drives engagement in innovation
- Increasing awareness of the regulatory environment drives engagement in innovation
- Increasing awareness of the knowledge environment drives engagement in innovation

H_2: The likelihood of a food company engaging in different types of innovation increases when certain supportive internal factors are in place

Specific to absorptive capacity, the extent of a company's ability to absorb external information will be positively related to:

$H_{3:}$ elevated levels of certain supportive internal factors (*i.e.* as above)

$H_{4:}$ the degree to which the firm perceives that the business environment has an impact on innovation activities

$H_{5:}$ the level of priority placed on both commercial and knowledge outputs

$H_{6:}$ engagement in technological innovation.

Chapter 7

Results and discussion- 1- The questionnaire

7.1 INTRODUCTION

This chapter sets out the results of the postal survey carried out among Irish food companies. It begins by presenting the sample profile. Following this, the type and level of innovation in the sample are reviewed. Next, the hypotheses arising from the literature and the first round of semi-structured interviews (as described in the previous chapter) are investigated and discussed. This discussion is presented in two stages. The first section relates to the hypotheses regarding the type of innovation occurring in food companies, and the associated influencing factors, with each independent variable from the model being discussed in detail. The second section focuses on the hypotheses that are specific to the factors influencing absorptive capacity in companies.

7.2 PROFILE OF SAMPLE

7.2.1 Profile of companies in the sample

Company size data are presented in table 7.1. SMEs made up over three quarters (76%) of the sample when assessed in terms of both employee numbers, reflecting the high proportion (90%) of SMEs in the Irish food industry (Teagasc, 2009). Companies in the 10-49 employee category comprised the largest grouping (40%), followed by those with 50-99 employees (20%) and the 100-249 employees (17%). When company size was assessed in terms of turnover (as per the definition provided by the EC), a slight difference was noted in the breakdown of the companies. However, as employee size is most routinely used to distinguish between company size, the initial breakdown took preference in this study.

Table 7.1: Reported company size of the sample of Irish food companies (EC Classification)

Size	***Employee Number***				***Turnover (million)***			
				***n* (%)**				***n (%)***
Micro	**<10**			**12 (9.4)**	**<€2**			**25(19.7)**
Small	**10-249**				**€10-49.9**			
		10-49	50 (39.4)			€2-9.9	36 (28.3)	
		50-99	25 (19.7)			€10-19.9	17 (13.4)	
		100-249	21 (16.5)			€20-49.9	20 (15.7)	
				96 (75.6)				**73 (57.4)**
Large	**>250**			**19 (15.0)**	**>€50**			**23 (18.1)**

A number of studies have suggested that SMEs are at a disadvantage in terms of innovation due to low levels of human capital, lack of finances for innovation (Traill and Grunert, 1997), limited absorptive capacity (Menrad, 2004) and diseconomies of scale (Nooteboom, 1994). However, within the group of companies surveyed in the present study, no significant difference was found across increasing employee number and level of engagement in technological innovation [χ^2 (4, *n*=117) = 6.20, p>0.05]. Traill and Meulenberg (2002) found a similar lack of agreement between increasing firm size and propensity to engage in product and process innovation among food SMEs in Europe. When examined in more detail, companies with larger numbers of employees were more likely to have engaged in process innovation in the last three years [χ^2(4, *n*=108)=20.11, p<0.001] compared with smaller companies (*e.g*. 76% of companies with 100-249 employees had engaged in technological innovation in the last three years in comparison to 40% of companies with 10-49 employees). These results suggest that the larger SMEs are more focused on process innovations than their smaller counterparts, possibly reflecting an increased level of internal resources available to implement capital-intensive process innovations. Conversely, as companies increase in size they may move away from niche markets to more mainstream products (possibly including the manufacturing of private label goods). As a result, increased competition (and retailer specifications regarding private label products and margins) may be driving process innovation as a means of increasing efficiency and reducing costs. This is supported by the significantly higher level of the 'new-to-company'/'incremental' process innovations in the larger companies [$\chi^2(4, n=70)=9.95$, $p<0.05$].

The survey sample was reasonably representative of the various sectors in the Irish food industry when compared to data provided by An Bord Bia[16] (pers. comm. 10th December 2010); there was some over-representation of the meat sector and under-representation of the marine and beverage industries (see figure 7.1). When the sectors were banded into four groups [meat, *n*=29; dairy, *n*=19; prepared consumer goods, *n*=26; and 'other' (*e.g*. marine, ingredients *etc*.) *n*=44], no significant difference was found in the prevalence of any of the types of technological innovation between sectors.

[16] It is important to note that while the survey sample was limited to companies with a manufacturing base in Ireland (excluding bakeries and small retail outlets), the companies listed in the Bord Bia database were confined to producers who do the bulk of their manufacturing and sourcing in Ireland (excluding retailers but including bakeries producing their own products and selling them through their own outlet).

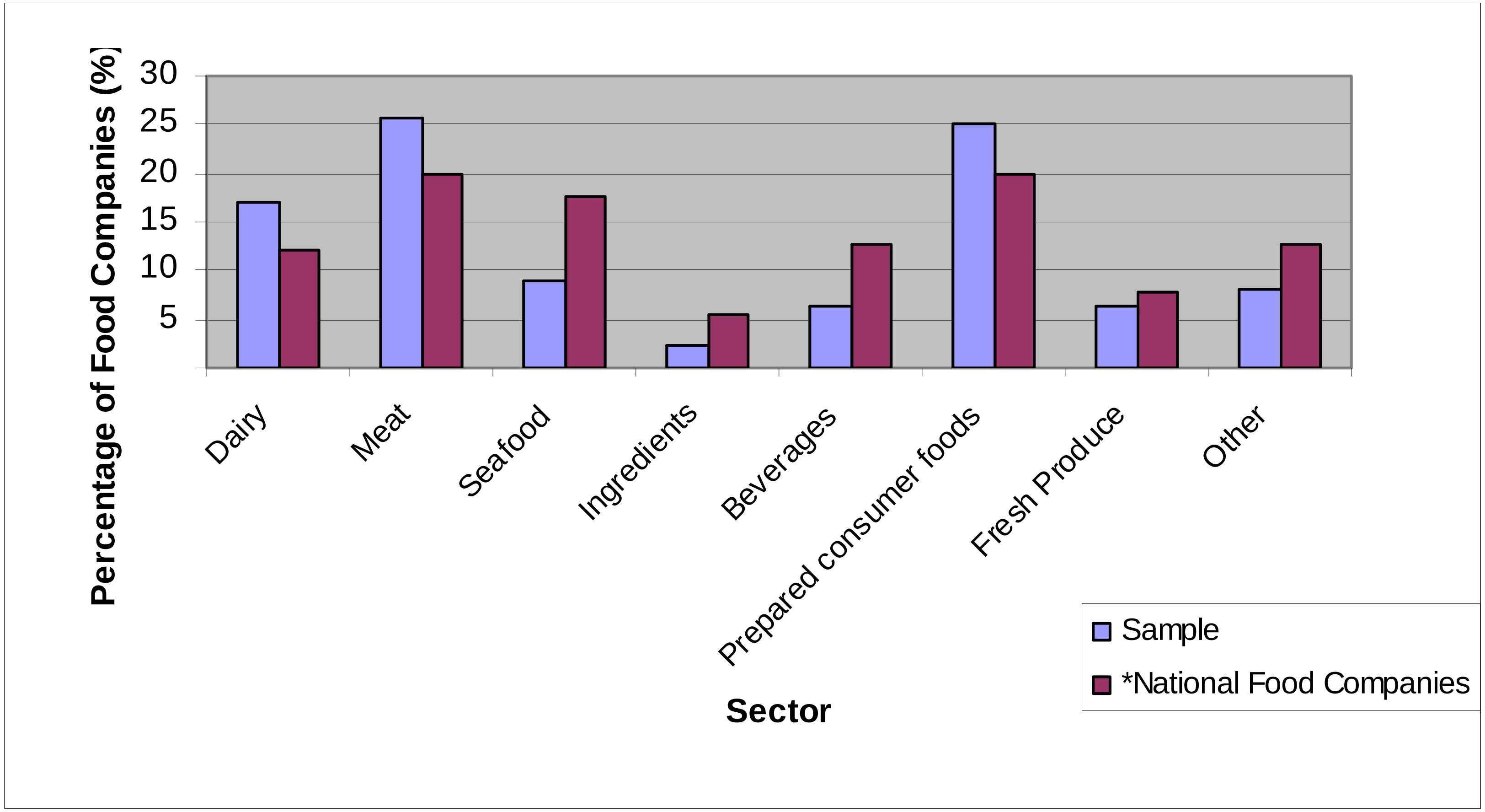

Figure 7.1: Comparison of sectoral breakdown of the Irish food industry with the survey sample of food companies (n=121)

** Source: Personal communication with Bord Bia (Dec, 2010)*

The sample was also representative of the regional spread of food companies in Ireland, with some under-representation of the Dublin region[17] and over-representation of the South-West region (figure 7.2). No significant difference was found between company innovation levels in the different sub-national governance regions of the country. This is a positive finding, as innovation can support the sustainability of food companies (Porter, 1985; Menrad 2004; Triall and Mulerberg, 2004; Sarkar and Costa, 2008) which make an important economic contribution to peripheral regions of the country (Department of Agriculture, Fisheries and Foods, 2010). This would suggest that economic clusters, as described by Porter (1990), have not evolved in the Irish food industry. This contradicts findings by O'Malley and Van Egeratt (2000); however, a possible reason for this is that the current research focused on SMEs as opposed to the larger dairy companies, as was the case in the former research. Due to the focus of this study, data was not obtained on the larger dairy companies.

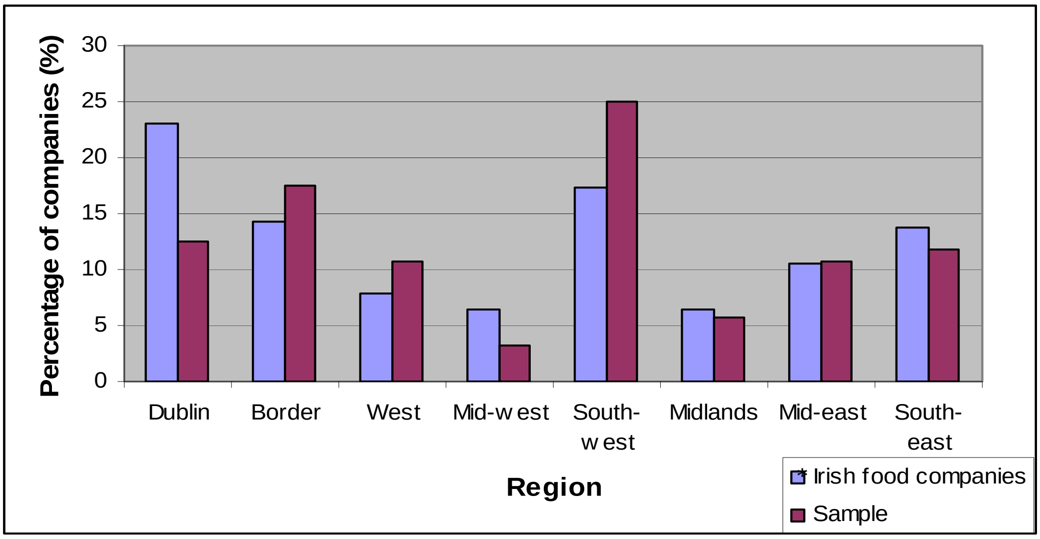

Figure 7.2: Comparison of regional breakdown of the national population of the Irish food industry with that of the food companies in the sample (n=121)

Source: Personal communication with Bord Bia (Dec, 2010)

[17] This under-representation in the Dublin region was accounted for in the first stage of in-depth analysis, which was based in Dublin and surrounding regions

As is the case in most Irish food companies (Bord Bia, 2009), the majority of the sample indicated that they exported their produce (78%; figure 7.3), with 51% selling to international wholesalers. Similar to previously reported data for the Irish agri-food sector (Bord Bia, 2009), the UK/NI was the most popular destination for exports (73%). However, as was highlighted in the Food Harvest report (Department of Agriculture, Fisheries and Foods, 2010), a considerable proportion of companies were found to be exporting to markets which were not affected by currency fluctuations (*i.e.* the Eurozone). In contrast to the findings of the Forfás (2011) survey of innovation activities, a higher propensity to engage in technological or administrative innovation was not found among companies who exported ($p>0.05$). A possible explanation for this lack of significance may be the heavy focus on the UK and European market among food companies. Markets which are further afield may necessitate both technological innovations (*e.g.* extension of product shelf life) and administration innovations (*e.g.* distribution chain innovation) to be feasible. Only process innovation was found to be significantly higher in food companies that engaged in export activities [$\chi^2(1, n=113)=5.51$, $p<0.05$]. This was particularly true for 'new-to-company'/'incremental'-type innovations, and thus may be possibly attributed to increasing price pressure in the UK market (contributed to by Sterling weakness against the Euro), increasingly stringent conditions of sale from foreign multiples (*e.g.* BRC[18]) and difference in customer profiles (*e.g.* different taste profiles in European countries than Ireland).

[18] British Retail Consortium Global Standards are a food safety quality certification program used by certificated suppliers in over 100 countries, details of which are available at: http://www.brcglobalstandards.com/

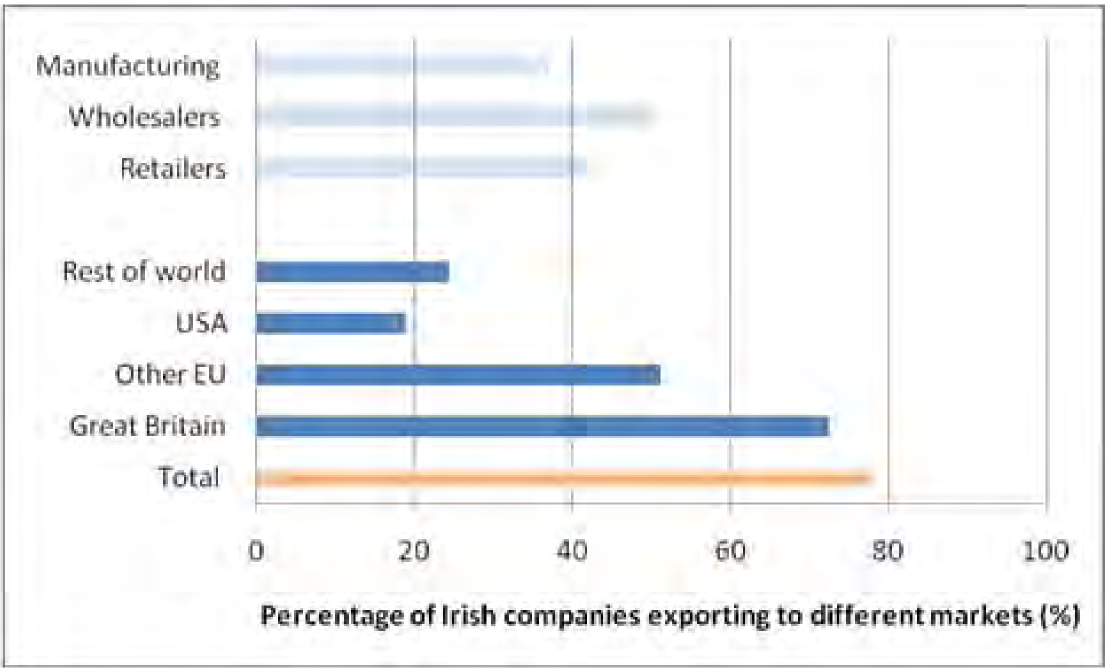

Figure 7.3: Type and location of export destinations for the sample of Irish food companies (n=93)

7.2.2 Profile of respondents

The majority of respondents were male (76%) (table 7.2). This is reflective of the established gender profile of the Irish food industry; in 2008 the majority of employees were found to be male (70%), and this had increased since 2004 (EGFSN, 2009). The managing directors were targeted in the smaller companies in the present company. These made up the largest portion of the respondents (48%). In the larger companies, the R&D or NPD managers were targeted, as they were thought to have the most appropriate knowledge to complete the survey.

Table 7.2 Descriptive statistics of respondents

	n (%)
Gender of respondent	
Male	91 (78.5)
Female	23 (19.2)
Job title	
Managing director	57 (47.5)
General manager	31 (25.8)
R&D manager/NPD manager	14 (11.7)
Quality Assurance Manager	14 (11.7)
Administration	4 (3.3)

The length of time that the respondents had spent in the food industry ranged from 6 months to 40 years [$\overline{x}$: 8.6 years]. The average length of time spent with the current company was 14 years. Table 7.3 presents a comparison of the length of time spent in the company and in the food industry between those who had and had not engaged in different types of innovation. Although Avermaete *et al.* (2004) found that longer experience in the food industry was positively related to innovation, no significant difference was found in this study with increasing experience in this sample. However, the mean length of time spent in the food industry was found to be significantly higher in companies that had not engaged recently in process innovation. These results suggest that there may be a relationship between increasing length of time in the industry and decreasing willingness to get involved in certain types of innovation. Mahon and Pitts (2005) attributed similar findings (in a sample of Irish food companies in the South West region of Ireland) to the possibility that younger managers bring new ideas to the firm and therefore inspire a greater number of innovations than older managers. Assuming the length of time in the industry is a function of the age of the respondent, this would suggest that increased age is linked with decreased innovation rates. Although Vroom and Pahl (1971) and Hitt and Tyler (1991) originally found a significant negative relationship between age and risk taking, various other studies have disputed this claim since then (Golden and Zajac, 2001; Inghwee and Qian, 2007).

Table 7.3 Comparison of the length of time spent in the company and in the food industry between those who had and had not engaged in different types of innovation

	Length of time with company (n=119)					***Length of time with industry (n=78)***				
	Yes		No		*t*-test	Yes		No		*t*-test
	Mean	*SD*	*Mean*	*SD*		*Mean*	*SD*	*Mean*	*SD*	
Product Innovation	13.2	9.3	17.6	7.4	2.29	10.9	7.4	11.9	6.9	0.01
Process Innovation	13.5	9.6	14.4	10.6	0.18	9.3	5.3	14.0	8.9	9.15**
Packaging Innovation	13.6	8.9	14.2	11.3	4.30	12.4	8.7	10.1	6.0	2.97
Technological Innovation	13.6	9.6	16.1	12.4	1.71	11.2	7.7	12.3	8.3	0.06

***Significant at 0.1%, **significant at 1%, significant at 5%

7.2.3 Level of absorptive capacity in the sample companies

The procedure used to develop measure 1 (M1) and measure 2 (M2) was detailed in Chapter Four. Table 7.4 presents a breakdown of the companies which were assigned to the different groups based on these measures. About a third (34%) of companies surveyed indicated a high level of receptivity to external sources of information (M1) (table 7.4). Approximately half (45%) of respondents who specified they had recently engaged in a technological innovation perceived the knowledge within both commercial and public sectors as being of value to their business (M2). Only a quarter (25%) of ‘innovators’ did not attribute value to external information sources within this context, while about a third (29%) placed a higher value on knowledge emanating from the commercial arena rather than that from the public sector. Cross-tabulation between the two measures showed reasonable agreement, and verified the co-incidence of high levels of openness to external sources of innovation and high levels of perceived value of such sources. Chi-square statistics confirmed the relationship between the two measures (χ^2 =13.15, $p<0.05$).

Table 7.4 Number and percentage of companies in the three levels of absorptive capacity for M1 and M2

	M1 **Level of openness to external sources of innovation (*n*=123)**	**M2** **Perceived value of different levels of external sources of innovation (*n*=95)***
	No. Companies (%)	**No. Companies (%)**
Level 1 (Lowest)	45 (36.6)	24 (25.3)
Level 2 (Middle)	36 (29.3)	28 (29.5)
Level 3 (Highest)	42 (34.1)	43 (45.3)

*As only companies which indicated they had engaged in a technological innovation were asked to complete the second measure, there are considerably less in this cohort.

7.2.4 Intellectual property protection

Hagedoorn (2003) opined that the food industry was not generally active in IP protection and had weak appropiability regimes. Despite this, the current figures indicated that the majority (71%) of this sample of companies engaged in some form of IP (see figure 7.4, outlining the number of companies who indicated that they engaged in different forms on intellectual property protection). Similar to the findings of Kitching and Blackburn (1999) in a sample of SMEs, informal or internal company mechanisms of protection were popular, with over a third of companies engaging in secret know-how (31%) and a quarter in non-disclosure agreements (25%). The popularity of trademarks (32%) far exceeded the other formal types of IP used and thus may be more suited to small food companies than patents (22%). The level of patent use reported appeared surprisingly high given that Avermaete *et al.* (2003) found a significantly lower level of patenting in their sample of 60 Belgian food manufacturers, with only 9% of companies indicating that they had a patent. Romijn and Albaladejo (2002) believed that innovations emanating from SMEs generally did not have the fundamental novelty required to qualify for a patent, despite being considered ‘new’ within the specific context of the business arena. Garcia-Matinez and Briz (2000) further developed this point by suggesting that innovations in the food industry may be less patentable due to the ‘carrier’ nature of the industry, in which innovations from other industries are absorbed and implemented, as opposed to being developed in-house. This observation contributes in part to the explanation of high prevalence of non-disclosure agreements in this sample. However, to follow this logic, licensing-in technology should also be commonplace in this sample, and this was not the case. Therefore, the results may indicate that Irish food SMEs eschew the more formal forms of IP in favour of the informal options available (non-disclosure agreements, secret know-how). While this may arise from a lack of awareness of the potential from formal IP protection as a source of competitive advantage (Forfás, 2004), the first round of semi-structured interviews indicated that a strategic decision had been made by some firms not to pursue IP protection. The interviewees attributed this to the perceived complexity and expense involved, and the lack of anticipated return from this investment.

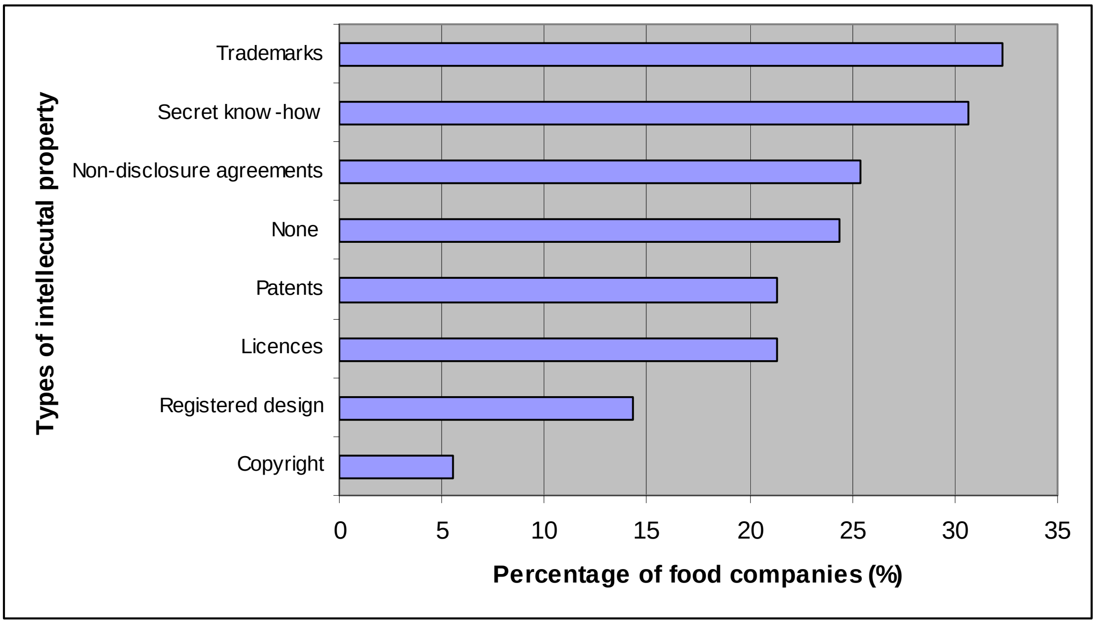

Figure 7.4: Percentage of the sample of Irish food companies engaging in intellectual property (IP) protection.

7.3 LEVEL AND TYPE OF INNOVATION IN A SAMPLE OF IRISH FOOD SMEs

7.3.1 Level of innovation

In general, high levels of each type of technological innovation were reported, with product innovation being most prevalent in this sample (78%), followed by packaging (57%) and process (53%) innovation. These levels are similar to those reported by Avermaete *et al.* (2004) in a survey of 177 food firms in six European countries including Ireland (*i.e.* product innovators 78%, process innovators 62%, and packaging innovators not considered separately). Non-innovator rates also compared to those found in Spanish food firms (Garcia Martinez and Briz, 2000); in both studies, approximately a tenth of companies indicated that they were not involved in innovation. In the current study, no association was found between sector, region or size of the company and non-engagement in innovation.

Data were also compared with results from the Community Innovation Survey (CIS) (CSO, 2010), which provides innovation statistics on Irish companies in the service and industrial sectors (for the period 2006-2008). Higher rates of product and process innovation were evident among the companies in the sample when compared to the industrial sector[19] in the CIS (figure 7.5). Although innovation in the CIS food companies (as signified by NACE code 15[20]) was higher than the average industrial innovation rates, this sample of companies exceeded even those rates. Packaging innovation rates were not considered as a specific category within the CIS, and could not be compared as a result.

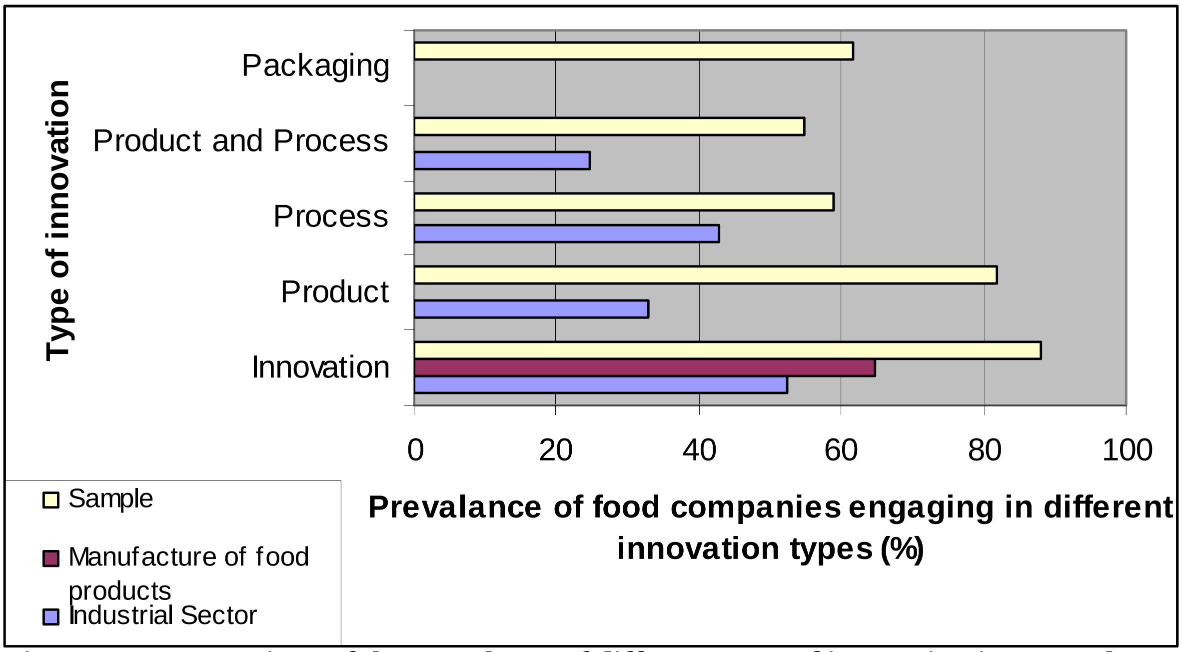

Figure 7.5: Comparison of the prevalence of different types of innovation in a sample of Irish food companies with the prevalence in the population of the industrial sector and population of manufacturers of food products as per the Community Innovation Survey. *(Community Innovation Survey, CSO, 2010),*

[19] When conducting the CIS, Forfás divides companies into service and industry sectors, the food manufacturing industry is included in the industry sector
[20] NACE codes are the European industrial activity classification which has been approved by the European Commission (CSO, 2011)

7.3.2 Type of innovation

7.3.2.1 Technological innovation

In an effort to account for the subjective nature of the term ‘innovation’ and to distinguish between levels of innovation, two options were included in the survey. The first (‘new-to-firm’) was taken to infer more incremental innovations, as competitors had already adopted such innovations. Innovations that are more radical were denoted by the second option (‘new-to-industry’). This strategy is in line with that employed by the CIS survey as derived from the OECD Oslo Manual, in accordance with the Commission Regulation (EC) No 1450/2004. As was found in previous studies which focused on the food industry [Garcia Martinez and Briz, 2000 (Spain); Avermaete *et al.*, 2003 (Belgium); Menrad, 2004 (Germany)], incremental or ‘new-to-firm’ innovations predominated over the more radical innovations in this sample of Irish food companies. This was true for all three types of technological innovation (figure 7.6). ‘Radical’ process and packaging innovations were particularly uncommon, and this may be due to the cost implications and associated risk of introducing such an innovation.

When looking at product innovations, Ernst and Young (1999) found that only 1.4% of new product introductions into the consumer goods industry in Europe (in the period June 1996 - July 1997) could be classified a ‘classically innovative’[21]. However, over 40% of the companies in this sample indicated that they had engaged in ‘radical’ product innovations in the last three years. Therefore, further investigation of the interpretation of the term ‘innovation’, and the elements that distinguish between different levels of innovation, within the specific context of the food industry, was warranted.

[21] Classically innovative was defined as “breakthrough products that appear to the consumer to bring true innovation to a category, or alternatively create a new category” Francis (1999:9). It should be noted that this definition does not take into account the level of risk, cost, or change required in a company to facilitate the adoption of such an innovation and is also limited to product innovations.

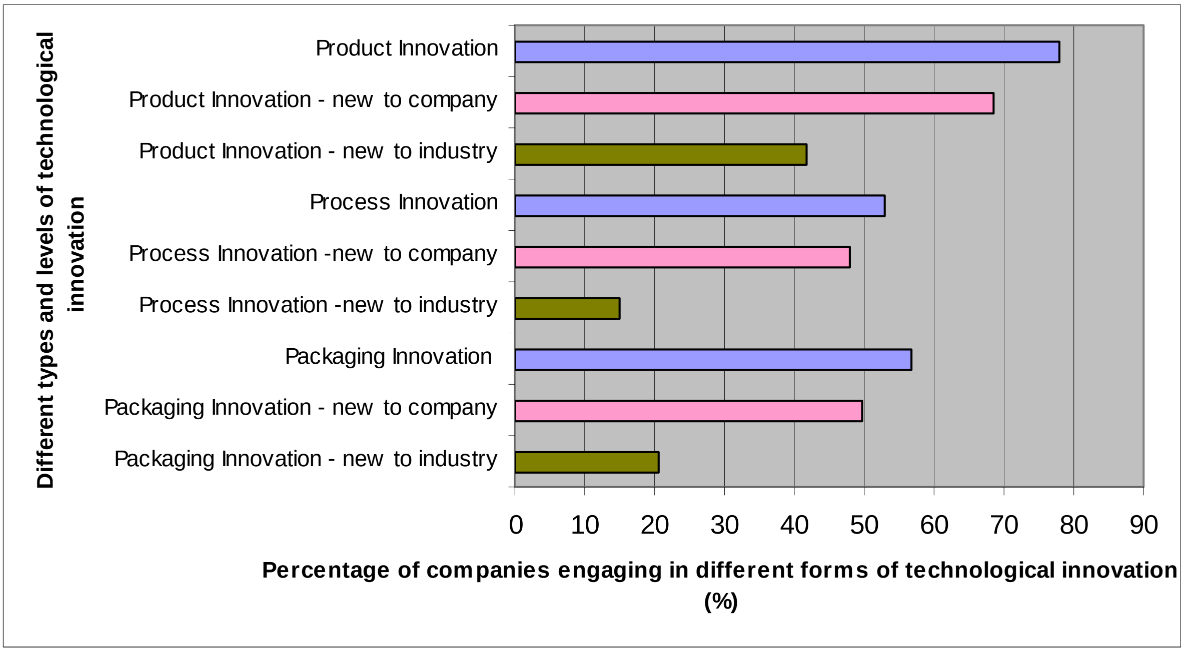

Figure 7.6: Prevalence of different types and levels of technological innovation in the sample of Irish food companies

7.4 Testing the hypotheses - Factors infleuncing innovation and absorptive capacity in food companies (Independent variables arising from the model of absorptive capacity)

H_1: Increasing awareness of the influence of the business environment drives engagement in innovation

- ***Increasing awareness of the competitive and operating environment drives engagement in innovation***
- ***Increasing awareness of the economic environment drives engagement in innovation***
- ***Increasing awareness of the regulatory environment drives engagement in innovation***
- ***Increasing awareness of the knowledge environment drives engagement in innovation***

7.4.1 External business environment

The first hypothesis aimed to examine whether the perception of extensive pressure from external business environmental factors drove innovation in Irish food companies. This hypothesis is divided into four separated yet interconnected hypothesises, the results of the investigation of which are discussed in the following sections. By investigating this hypothesis, the hierarchy companies attribute to the barriers and drivers of innovation was also explored. In doing this, an original research objective was addressed.

7.4.1.1 Operating and competitive environment

The first component of hypothesis one looked in particular at the competitive and operating environmental factors facing food companies in Ireland. In terms of the factors perceived as having the most impact on innovation in food companies, consumer trends ($\bar{x}$ =3.6) scored on average the highest from a pre-defined list of external business environmental factors (developed from the literature and semi-structured interviews) (see figure 7.7). Respondents deemed consumer trends to be encouraging of innovation (see figure 7.8 which presents results of the perception of whether different environmental factors encourage [above the baseline] or inhibit innovation [below the base line]. The distance from the baseline indicates the level of encouragement or inhibition. The spread across the Y axis is for ease of reading). In contrast, the factor that scored second highest (‘state of the economy’) was thought to be constraining innovation activities in companies. ‘Lack of credit availability’ and unfavourable ‘exchange rates’ were also deemed to be affecting innovation in this way. The power of retailers and the competitive nature of the industry were also influencing food companies in the sample, with both factors encouraging innovation. In contrast, tax incentives and suppliers were not perceived as having as much impact on innovation activities. The low perceived relevance of tax incentives for this sample was investigated further in the next stage of the research.

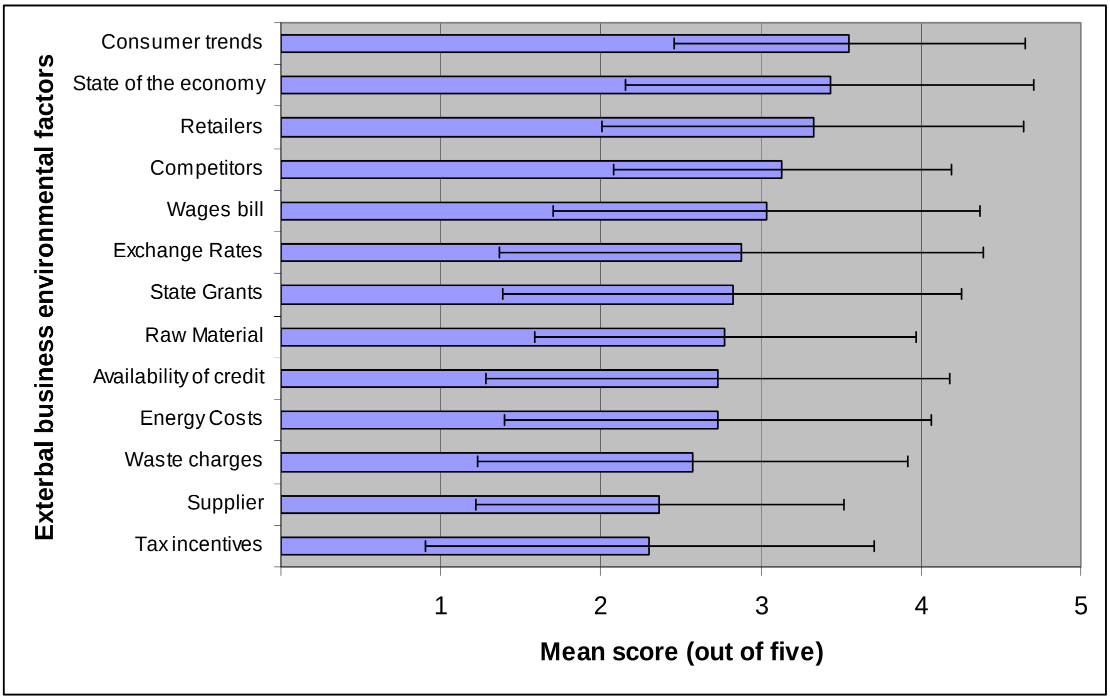

Figure 7.7: Average perceived influence of external businesses factors on a sample of Irish food companies

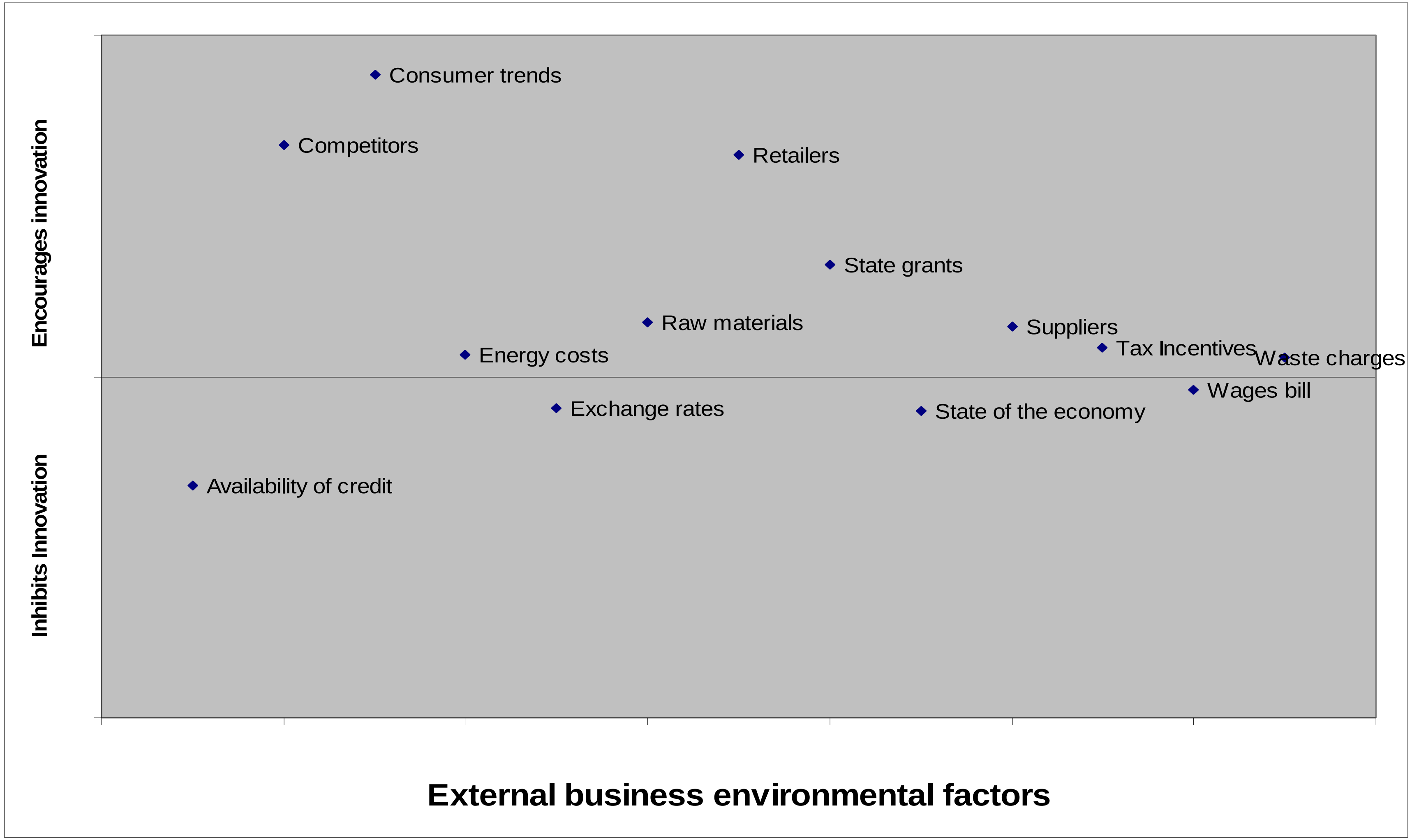

Figure 7.8: Perceived incentives and disincentives to innovation arising from the business environment *(factors above the line denote those encouraging of innovation, those below the line are factors thought to be inhibiting innovation, the further from the line, the stronger the perception of the impact on innovation)*

In this sample, both product and process innovators perceived a higher level of impact from the industry environment (competitors, suppliers, consumers and retailers) than those not innovating. [*i.e.* product innovator ($\bar{x}$ = 3.21 SD=0.83) versus product non-innovator ($\bar{x}$ = 2.67, SD = 0.99), *t* (121) =2.31, p<0.05; process innovators ($\bar{x}$ = 3.30 SD=0.83) versus process non-innovator ($\bar{x}$ = 2.95, SD = 0.81), *t* (121) = 2.07, p<0.05]. Operating costs were also significantly more of an influencing factor for those involved in process innovations ($\bar{x}$ = 3.47 SD = 0.95) compared to those who were not ($\bar{x}$ = 3.07 SD=1.05) [t(121) =2.87, p<0.01]. Mounting operating costs may be driving innovation in order to reduce this outlay.

Looking specifically at the impact that individual environmental factors have on the types of innovation occurring in food companies; product innovators were found to be significantly motivated by consumer trends [engaged in product innovation: yes; $\bar{x}$ =3.4, SD=1.1, no; $\bar{x}$ =2.9, SD=1.0, t(121)=2.64, p<0.01]. This is a positive finding when considered in light of the recent *Food Harvest 2020* report, which stressed the importance of consumer orientation for sustained competitive advantage (Department of Agriculture, Fisheries and Food, 2010). Conversely, the factors motivating the process innovators mainly stemmed from concerns over operating costs, and in particular the cost of energy [engaged in process innovation: yes; $\bar{x}$ =3.0, SD=1.3, no; $\bar{x}$ =2.4, SD=1.3, t(121)=2.49, p<0.05] and the wage bill [engaged in process innovation: yes; $\bar{x}$ =3.4, SD=1.3, no; $\bar{x}$ =2.6, SD=1.3, t(121)=2.92, p<0.01]. Interestingly, input from retailers was also felt to be driving process innovation efforts in companies [engaged in process innovation: yes; $\bar{x}$ =3.7, SD=1.3, no; $\bar{x}$ =3.0, SD=1.3, t(121)=2.40, p<0.05]. This finding is in accordance with opinions of interviewees in the first round of interviews and also Stewart-Knox *et al.* (2003), who found that retailers' exacting conditions of supply were encouraging innovation.

7.4.1.2 Economic environment

The second component of hypothesis two focused on the factors in the economy that challenge food companies in Ireland. In this study, the 'state of the economy' was found to be the second most important factor influencing innovation in food companies. This was true for both innovators and non-innovators, as no significant difference was found between the two groups. Only exchange rates were significantly different, with those engaging in process innovation ($\bar{x}$ = 3.2, SD = 1.5) perceiving a higher impact on innovation activities than those not engaging in this type of innovation [($\bar{x}$ = 2.5, SD 1.4), *t* (121) =2.78, p<0.01]. In accordance with the earlier findings that exporting companies had a higher propensity for 'new-to-company' process innovations, pressure to remain competitive in the Sterling market may be driving the improvements in efficiencies for Irish food firms.

Packaging innovators did not appear to be significantly motivated by any of these considerations. Innovating through packaging alterations and new packaging are important avenues for food companies (Earle, 1997) and the drivers of such innovations were investigated further in the second round of qualitative interviews.

7.4.1.3 Regulatory environment

Thirdly, the hypothesis examined the relationship between the perception of the regulatory environment and the occurrence of innovation in Irish food SMEs. Modern food legislation has been noted as being relatively extensive and complex (Binns, 2009). The arguably restrictive nature of European legislation (Health and Nutrition Claims legislation and Novel Foods Legislation) is suspected to have affected food innovations negatively in recent years (Goldstein and Carruth, 2005; Coppens *et al.*, 2006; Bech-Larsen and Scholderer, 2007; Hermann, 2009). However, the need to comply with evolving legislation may also be inspiring and driving innovation in some companies. In this sample, the HACCP[22] (89%) regulation affected the largest number of companies in terms of requiring change within the company (see figure 7.9). Labelling requirements, such as those for nutritional information (83%) and allergens (79%), also influenced a considerable number of companies. British Retail Consortium (BRC) standards were perceived to be of greater importance for innovation than ISO regulations. Respondents citing Bord Bia Quality Assurance Schemes[23] were less prevalent, perhaps explained by their varying specific sub-sectoral relevance. Chi-squared analysis of variance between sectors showed significant difference between sectors [χ^2 (8, n=92)=27.2, $p<0.001$], with the Bord Bia regulation dominating in the meat (83%) and fresh produce (83%) sectors, far exceeding the dairy (13%) and seafood (0%) sectors.

The means by which the respondents ranked the regulations of importance supports the claim that incremental innovation is favoured in the Irish food industry.

[22] HACCP (Hazard Analysis and Critical Control Point) is a system that allows the identification and control of any hazards that could pose a danger to the preparation of safe food (FSAI, 2010). It is legislated under the European Commission Regulation 852/2004/EC

[23] Bord Bia provides quality assurance schemes for the following product sectors: beef, lamb, pigmeat, poultry, eggs and horticulture (Bord Bia, 2010)

The Novel Foods and Novel Ingredients EC (No.) 258/97 regulation was not perceived to be relevant to the majority of companies in this sample. For a company to engage with this regulation, a level of radical innovation would be necessary (*e.g.* collaboration with a research organisation/extensive in-house R&D to acquire scientific support for the safety and possible utilisation of a product or process, see Appendix II for examples of products and processes that have been accepted under 258/97/EC). The low ranking of this regulation reflects results from the first round of semi-structured interviews in which respondents surmised that such legislation was only of relevance to the few companies operating in that "space" and therefore did not affect the majority of Irish food companies. The interviews revealed that although some companies may have been unaware of the potential benefits of pursuing this means of competitive advantage, others had made a strategic decision not to get involved in this area; reasons stated for the latter included a perceived low return on investment and the high costs involved.

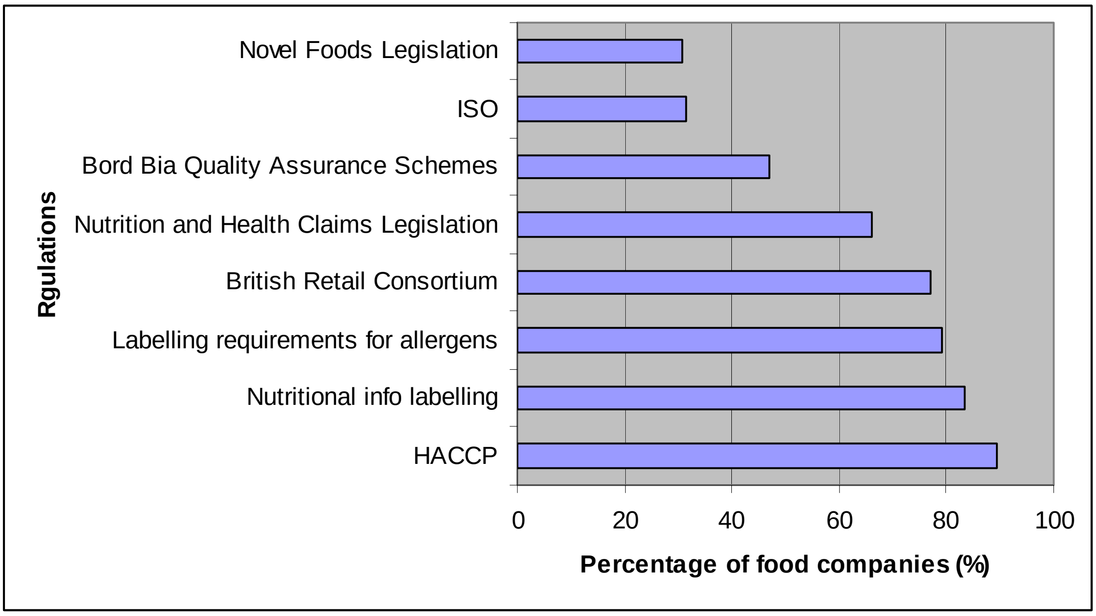

Figure 7.9: Percentage of companies who perceive different regulations have an impact on their innovation activities

The Nutrition and Health Claims legislation (1924/2006/EC) was adopted in December 2006. Due to the subsequent release of opinions on permissible claims (in the period August 2008 - June 2011) and the associated media attention, this regulation was of particular interest in this study. Respondents were asked, “In what way has the Nutrition and Health Claims Legislation affected your company’s innovation activities?” Over 70% of companies indicated that it had some impact on company activities. The most common consequence cited was label adaptation (69%) (figure 7.10). Additionally, the legislation was considered to have caused a rise in the cost of NPD (in terms of resources committed to R&D and staff training). The legislation appeared to have a higher impact on company products than on processes. Companies also felt an increased need for external support in order to be able to comply with the legislation, and a considerable percentage indicated they had reformulated products because of it (47%). Potential was identified for support-agencies to provide targeted assistance in terms of ‘adapting of labels’. The technical support required in the ‘reformulation of products’ may stimulate increased collaborations with TLIs and research institutes.

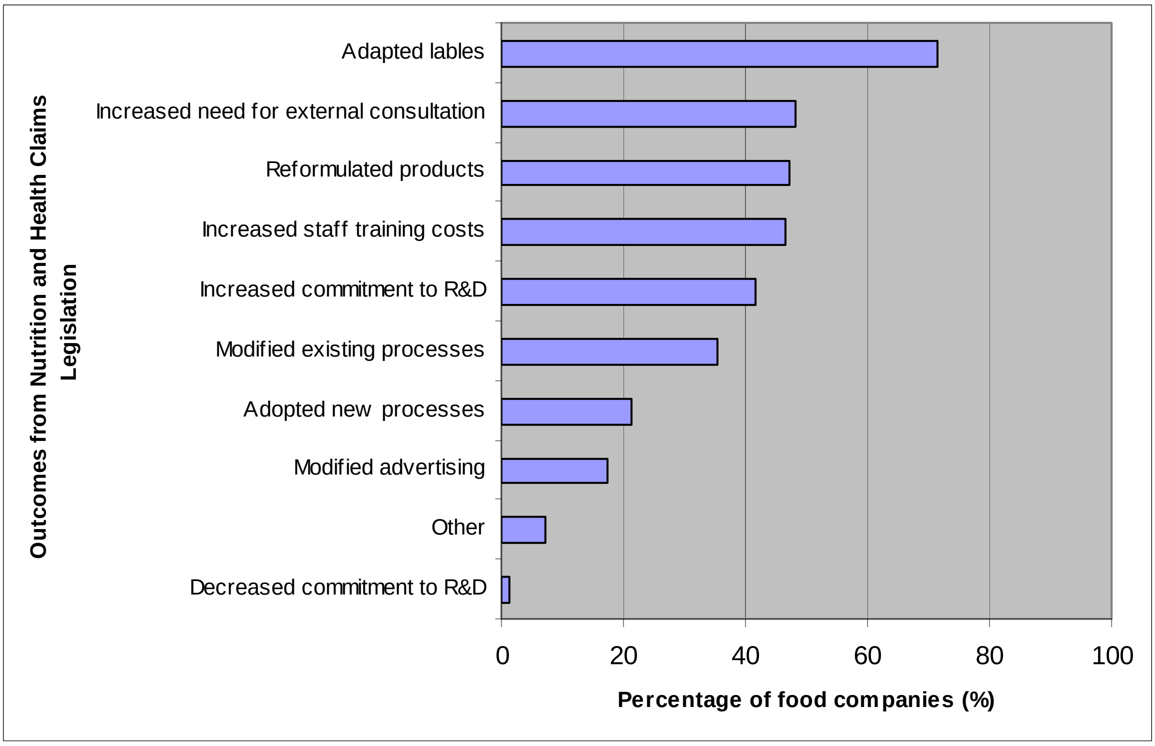

Figure 7.10: Percentage of a sample of Irish food companies affected by different outcomes of the Health and Nutrition legislation (1924/2006/EC)

7.4.1.4 Knowledge environment

Finally, within hypothesis one the element of the knowledge environment was investigated. When looking at the influence of knowledge sources, the questionnaire asked companies to differentiate between external sources, according to which of the three stages of the absorptive capacity process they perceived to be of most value (idea generation, assimilation, commercialisation; Cohen and Levinthal, 1990). A number of studies have suggested that information from commercial bodies (*e.g.* suppliers, clients/customers and competitors) is of most importance for successful new product development (Stewart-Knox and Mitchell, 2003). However, publicly-funded research has also been demonstrated to have an acceleration effect on both incremental and radical innovation in companies (Salter and Martin, 2001; Bishop *et al.,* 2010). In terms of the sources that Irish food companies believed to be most valuable for innovation activities, customers were identified as being of primary importance (χ^2=4.1) (see Figure 7.11). Respondents indicated that this was particularly pertinent from the perspective of idea generation. This finding is again in line with the envisaged increase in focus on customer-orientation cited in the *Food Harvest 2020* report (Department of Agriculture, Fisheries and Food, 2010). However, solely relying on input from consumers may restrict potential innovations to more incremental innovations, as the imagination of consumers may be the constraining factor[24]. Commercial entities such as competitors (χ^2=3.5) and suppliers (χ^2=3.4) also scored highly, again particularly in terms of idea generation. The non-commercial group that scored most favourably was Enterprise Ireland (χ^2=3.7), with a large number of companies valuing their input into idea generation and help with the integration of innovations into a company. For under a quarter of respondents, the input from Bord Bia (χ^2 = 3.4) was important from an innovation commercialisation perspective, as well as for idea generation. County Enterprise Boards (χ^2 = 2.6) were not deemed to be of relevance to a considerable number of companies and this may explain their low score[25]. Commercial entities (suppliers and competitors) seemed to be favoured over the non-commercial bodies (TLIs and Teagasc) for the majority of companies; this finding will be further developed when looking at absorptive capacity in firms.

[24] Henry Ford demonstrated an example of how consumer imagination can potentially constrain innovation; when discussion innovations in the transport industry at the beginning of the 19th century he is quoted to have said, “If I had asked people what they wanted, they would have said faster horses.”
[25] The remit of CEBs is to provide support for small businesses (‘micro-enterprises’) with 10 employees or less, at local level (City and County Enterprise Boards, 2009). Conversely, support from Enterprise Ireland extends to High Potential Start-Up companies, SMEs, larger companies (>250 employees) and Irish-based food and natural resource companies, that are overseas-owned or controlled (Enterprise Ireland, 2010b).

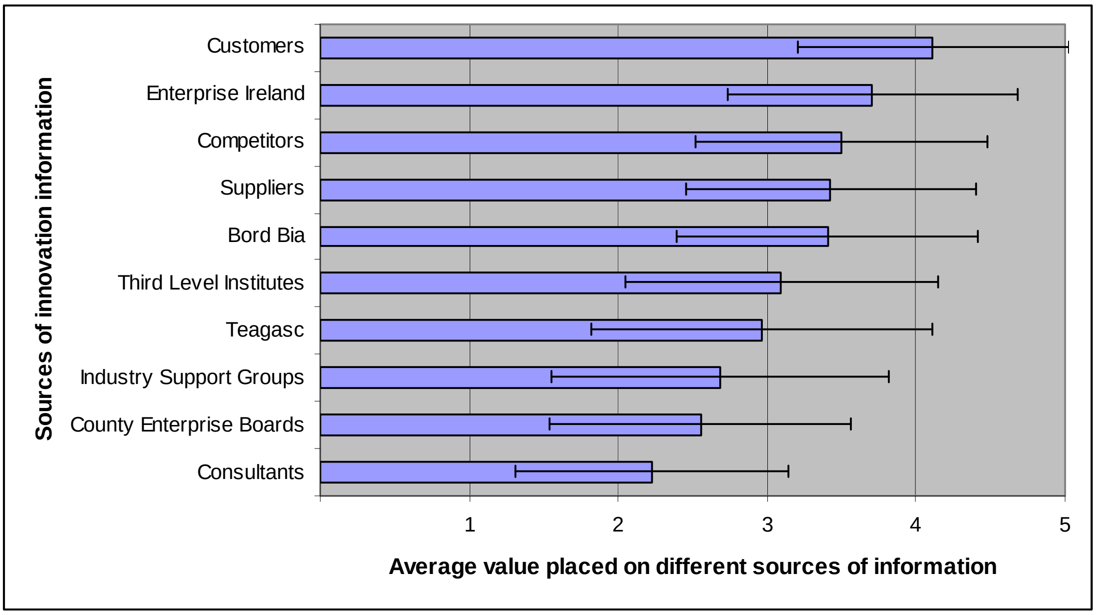

Figure 7.11: Average value placed on different knowledge sources by the sample of Irish food companies

When investigating the association between the value placed on different knowledge sources and the level of innovation, two significant relationships emerged. Firstly, in terms of product innovators, the value placed on An Bord Bia's input was significantly lower for those who indicated they had engaged in 'incremental' innovations ($\bar{x}$ =3.1, SD=1.1) than those who had engaged in both 'radical' and 'incremental' innovations ($\bar{x}$ =3.7, SD=1.0) [$t(n{=}69){=}{-}2.23$, $p<0.05$]. Therefore, input from Bord Bia was perceived as useful both in terms of incremental innovation (such as line extensions into new flavours), but also in terms of more radical innovations (such as sourcing the idea for new-to-country innovations on trade missions abroad). Secondly, the input of TLIs was more highly valued by those who engaged in both 'radical' and incremental' ($\bar{x}$ =3.8, SD=0.8) than those who had engaged in 'incremental' innovations ($\bar{x}$ =3.1, SD=1.0) [$t(n{=}47){=}45$, $p<0.05$]. Similar to findings by Romijn and Albaladejo (2002), the evidence suggests that the knowledge available from universities and research organisations may be relevant to those engaging in innovations that are more radical.

7.4.1.5 Hypothesis$_1$

In summary, in support of the combined first hypothesis, the evidence from this sample suggests that the way in which a company perceives the external business environment affects the level and type of innovation in Irish food companies. In terms of the hierarchy of drivers and barriers to innovations, the paramount importance of consumer trends was evident, and particularly so for product innovations. The ‘state of the economy’ was the next most important factor, affecting both innovators and non-innovators alike. The power of retailers and the competitive nature of the industry also ranked strongly. The need to comply with health and safety legislation and requirements regarding labelling and allergens appeared to be of principle importance from a regulatory perspective. When looking at the knowledge environment, the way in which companies ranked the importance of different knowledge sources seemed to be determined by the stage of the process of absorptive capacity that they were finding problematic. This finding was investigated further in the next stage of the research. On a final note, the type of innovation a company engaged in also appeared to be influencing the way such companies ranked the importance of the business factors, with process innovators driven by operating costs and exchange rates, in contrast to product innovators, which focused on consumer trends. Therefore, a complex relationship was observed, in which the business environment was found to be both constraining and driving innovation in firms.

7.4.2 Internal supportive factors

> ***H_2: The likelihood of a food company engaging in different types of innovation increases when certain supportive internal factors are in place (e.g. expenditure on training, educational qualification, communication linkages, undertaking NPD, formal strategy for innovation, culture for innovation, and managerial involvement in NPD)***

By investigating the second hypothesis, it was hoped to facilitate the determination of the current innovation capacity of Irish food companies through examining the internal attributes that contribute to an increased ability to innovate. In doing so, another of the research objectives was addressed.

7.4.2.1 Mental Models

7.4.2.1.1 Training

Training spend *per capita* was not significantly related to increasing company size or to engaging in any of the forms of technological innovation. In accordance with the findings of Cantillon *et al.* (2008), food regulation (87%) was the favoured avenue for training expenditure in companies (see figure 7.12). Following this, training investment was directed towards new product development (71%), sales and marketing (70%) and innovation (63%).

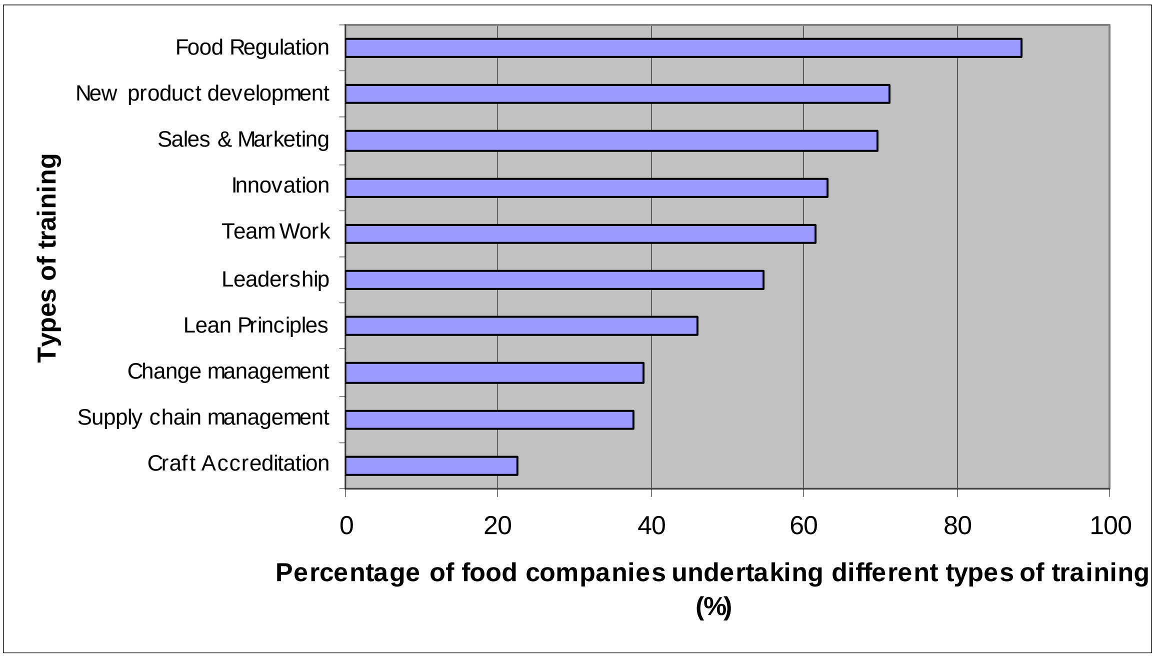

Figure 7.12: Training used by sample of Irish food companies

When examining the relationship between different types of innovation and training expenditure, a number of interesting points emerged (see table 7.5 which presents a comparison on the types of training which were of more importance in the firms engaging in different forms of technological innovation). Investing in 'innovation' and 'new product development' training appeared to be beneficial in terms of all three types of technological innovation. Therefore, devoting funds to such types of training may be a worthwhile investment. However, this did not translate into significantly higher levels of more 'radical' innovation ($p>0.05$). In addition to this, process innovation seemed to benefit from training in 'lean principles'. Conversely, packaging innovation appeared to be increased in companies that had engaged in 'sales and marketing', 'leadership' and 'team work' training. Input from employees who had increased their knowledge of customer desires through sales and marketing training could logically have formed opinions on optimal formats of packaging. However, the increase in the prevalence of packaging innovation in companies that had engaged in ‘teamwork’ and ‘leadership’ training is more difficult to understand.

Despite the finding that nearly half of companies were seeking assistance with the stipulations imposed by the Nutrition and Health Claims legislation, no relationship was found between innovation and training in ‘food regulation’. This suggests that such training focuses on the health and safety aspects of legislative demands, and on supporting existing products as opposed to facilitating the development of new products. Building on this, there may be potential for support-agencies and research organisations to provide training that capitalises on this particular market niche. Differences in the types of training that companies engaged in across varying levels of absorptive capacity are further developed in the following sections.

Table 7.5 Comparison of types of training engaged in across different types of technological innovation

	Product innovation			Process innovation			Packaging innovation		
	Yes ***(n=76)*** ***%***	**Total** **(*n*=124)** **%**	**χ^2** **(*p* value)**	***Yes*** ***(n=54)*** ***%***	**Total** **(*n*=114)** **%**	**χ^2** **(*p* value)**	***Yes*** ***(n=54)*** ***%***	**Total** **(*n*=114)** **%**	**χ^2** **(*p* value)**
Craft Accreditation (*n*=69)	93.3	87.0	0.16	76.9	65.9	0.41	57.1	57.6	0.00
Supply chain management (*n*=72)	88.9	87.5	0.00	77.8	66.2	1.90	74.1	58.0	3.70
Change management (*n*=71)	89.3	85.9	0.10	81.5	66.7	3.46	65.4	57.6	0.61
Lean Principles (*n*=75)	94.1	88.0	1.27	87.9	70.4	7.52**	71.0	66.0	2.03
Leadership (*n*=72)	87.2	86.1	0.00	72.5	66.7	0.90	71.1	58.8	4.24*
Team Work (*n*=81)	90.0	87.7	0.22	70.8	64.9	1.32	69.6	57.3	6.04*
Innovation (*n*=75)	97.9	89.3	7.96**	74.5	64.8	4.52*	71.7	57.7	8.92**
Sales & Marketing (*n*=85)	93.1	89.4	1.54	70.4	67.5	0.29	76.4	65.4	7.61**
New product development (*n*=82)	94.9	89.0	5.48*	77.2	68.8	5.71*	71.9	61.5	7.10**
Food Regulation (*n*=99)	87.4	85.9	0.50	62.2	60.9	0.16	65.5	63.2	0.93

***Significant at 0.1%, **significant at 1%, significant at 5%

7.4.2.1.2 Qualification level

The *Future Skills Requirement of the Food and Beverage Sector* report (EPFSN, 2009) stated that there was a decrease in the number of workers with low or no formal qualification[26] working in the food industry (between 2004 and 2008). Furthermore, there has been a concurrent (17%) rise in the number of workers with a third level degree or fourth level qualification, which now equates to nearly a quarter (22%) of the food industry work force. This shift towards higher qualified employees was deemed reflective of the increasing complexity of the industry and the resultant dependence on more advanced skills. Post-school qualifications are hypothesised to contribute to technical, communication and social skills, and in turn, to contribute to improving innovation capability (Avermaete *et al.*, 2004). The majority of NPD staff in this sample had achieved primary (28% of companies) or masters (25%) degrees (table 7.6), while 8% of companies indicated that they had a PhD graduate(s) working in their company. A number of studies found innovation to be more frequent in companies with higher incidences of qualified scientists and engineers (QSEs) (Romijn and Albaladejo, 2002; Koc, 2007; Stendal and Roos, 2008). However, although not a direct comparison, in this study increasing qualification levels were not found to be significantly associated with higher rates of technological. This may be reflective of the predominance of incremental innovation in Irish food companies; as such innovations are not thought to require substantial scientific or engineering experience (Rominjn and Albaladejo, 2002).

[26] This includes those with no formal or primary education and those with a low secondary education

Table 7.6 Reported highest level of educational qualification in the NPD departments of a sample of Irish food companies

	n (%)
1 = Secondary School	6 (4.7)
2 = 3rd Level Certificate/Diploma	15 (11.8)
3 = Primary Degree	35 (27.6)
4 = Masters	32 (25.2)
5 = PhD	11 (8.7)

7.4.2.2 Communication linkages

Mentoring and coaching was the most prevalent form of internal communication linkage in this sample of companies (78% of companies) (Figure 7.13). Cross-functional teams (68% of companies) followed this. When a more detailed analysis of the make-up of the NPD cross-functional team was conducted, the sales (99% of companies with a NPD function), quality control (98%), production (97%), marketing functions (95%) and the MD (90%) were the most highly represented. Accounting (77%) and engineering (65%) functions were less well represented. Looking specifically at the possible role of the accountant in NPD, a number of authors have cautioned against the use of strict short-term economic objectives when investigating the benefits of radical innovations, as it had previously prevented major manufacturing breakthroughs (Shank, 1996; Morgan and Daniels, 2001). However, strict financial control is vital within the tight margin food industry. Additionally, in terms of the input of engineering into NPD, feedback from the first round of interviews indicated that engineering had a positive effect on the success rates of scale-up from concept to commercialisation. Therefore, their increased inclusion may have a potentially beneficial effect. However, due to resource and human capital limitations, not all SMEs will have access to such a resource. Consequently, this gap could potentially be filled by the expertise available in support-agencies and TLIs.

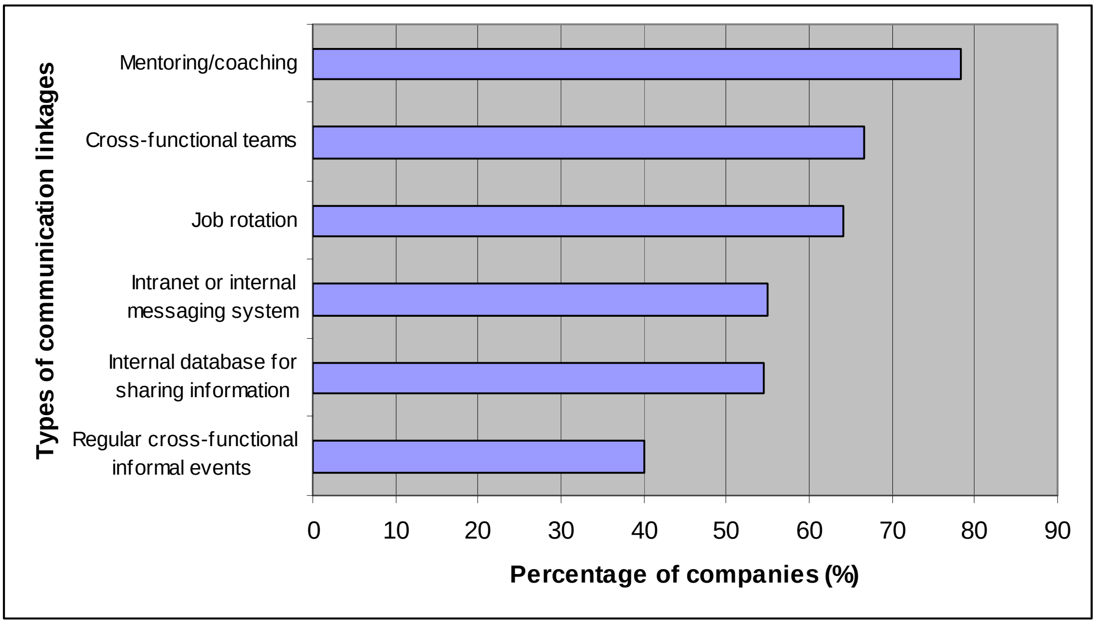

Figure 7.13: Breakdown of communication mechanisms in sample of Irish food companies

Sarkar and Costa (2008) and Tepic *et al*. (2009) encouraged the use of cross-functional teams in improving outcomes from innovation activities. In this study, such multi-disciplinary teams appeared to be particularly beneficial from the perspective of process and packaging innovators (see table 7.7). In terms of product innovators, both an internal messaging system and an internal database for idea sharing seemed to be more important. Although job rotation was quite popular, it may have limited applicability in smaller companies, and multi-tasking may be more appropriate.

Table 7.7 Comparison of presence of different types of communication linkages across technological types of innovator

	Product innovation			**Process innovation**			**Packaging innovation**		
	Yes ***(n=76)*** ***%***	**Total** **(*n*=124)** **%**	**χ^2** **(*p* value)**	***Yes*** ***(n=54)*** ***%***	**Total** **(*n*=114)** **%**	**χ^2** **(*p* value)**	***Yes*** ***(n=54)*** ***%***	**Total** **(*n*=114)** **%**	**χ^2** **(*p* value)**
Job rotation for new employees	86.1	81.4	2.10	61.8	57.5	0.94	59.1	60.7	0.81
Mentoring new employees	83.9	82.0	0.49	62.7	60.6	0.37	60.5	60.0	0.00
Internal messaging system	90.0	81.0	6.13*	68.4	60.6	2.71	66.1	59.0	20.1
Cross-functional teams	86.5	81.7	2.66	68.4	60.6	4.75*	66.7	59.0	3.96*
Internal database	89.5	80.6	5.24*	65.5	63.2	0.99	61.8	57.6	0.56
Regular cross-functional informal events	92.9	81.0	5.21	67.5	60.0	1.09	64.1	57.4	0.76

***Significant at 0.1%, **significant at 1%, significant at 5%

The number of communication linkages was found to be higher in the firms that were conducting product and process innovation (see table 7.8). This was not true for packaging innovators. These findings reinforce the view of Fosfuri and Tribó (2008) and Zahra and George (2002), that the existence of formal and informal knowledge transfer-mechanisms within a company facilitates optimisation of knowledge integration. The enhanced innovation opportunities, seen with increasing density of communication linkages, has been attributed to the instilling of a culture of trust and cooperation within such firms (Stewart-Knox and Mitchell, 2003; Cormican and Sullivan, 2004; Fosfuri and Tribó, 2008).

Table 7.8 Comparison of level of communication linkage density between those who had and had not engaged in different types of innovation

	Communication linkage density (n=121)				
	Engaged in innovation		*Not engaged in innovation*		*t*-test
	Mean	SD	Mean	SD	
Product Innovation	3.45	1.76	2.23	1.95	0.32**
Process Innovation	3.63	1.60	2.74	2.01	4.83*
Packaging Innovation	3.18	1.83	3.02	1.89	0.26
Technological Innovation	3.33	1.78	2.00	2.00	0.03*

***Significant at 0.1%, **significant at 1%, significant at 5%

7.4.2.3 NPD and R&D function

The majority of companies indicated that they had a dedicated NPD function (60%) and nearly half of companies signified they also had a devoted facility (49%) (See table 7.9). This equates to over ten percent of companies in which the NPD function did not take place in a formalised facility or function. Kitchens were the most popular NPD facility (42%), with just under a fifth of companies indicating they had a pilot plant (19%). Due to the availability of pilot plant facilities in external locations (such as Teagasc, Ashtown and Moorepark, and Queen’s University Belfast), the low level of pilot plants may not be particularly influential on the ability of companies to innovate. As described in the methodology chapter, a proxy was used to determine the level of research ongoing in the sample of companies. Nearly half of the companies (43%) had engaged with Enterprise Ireland R&D grant schemes in the last three years, and thus were assumed to have a more advanced level of R&D ongoing.

Table 7.9 Prevalence of varying levels of NPD and R&D in the sample of Irish food companies

	***n* (%)**	***n* (%)**
NPD Function		76 (59.8)
NPD Facility		62 (48.8)
Kitchen	53 (41.7)	
Laboratory	32 (25.2)	
Pilot Plant	24 (18.9)	
R&D grant from Enterprise Ireland		54 (42.5)
R&D tax credit		27 (21.3)

All types of technological innovation were found to be significantly increased in companies that indicated they had an NPD department (see table 7.10). However, the proxy (indicating a more advanced level of R&D) was found only to be significantly related to process innovation. These results suggest that more advanced in-company innovation activities may not be necessary for product and packaging innovation. Alternatively, such innovations may be currently outsourced. It also points to the possibility that the majority of innovations taking place in food SMEs in Ireland are incremental in nature.

Table 7.10 Comparison of the level of NPD/R&D across different types of technological innovator

	NPD function in place				Engaged with Enterprise Ireland R&D Grant scheme			
	Yes (n=76) %	**No (*n*=48) %**	**Total (*n*=124) %**	**χ^2 (*p* value)**	***Yes (n=54) %***	**No (*n*=60) %**	**Total (*n*=114) %**	**χ^2 (*p* value)**
Product innovation	91.8	64.4	81.4	11.97***	88.9	73.2	80.9	3.42
Process innovation	67.6	43.2	58.0	5.60**	71.4	48.2	59.0	4.91*
Packaging innovation	70.4	46.7	61.2	5.58**	69.2	54.5	61.7	1.86
Technological innovation	93.4	79.2	87.9	4.36*	98.1	78.3	87.7	8.60**

***Significant at 0.1%, **significant at 1%, significant at 5%

7.4.2.4 Formal strategies and firm culture

Although 61% of companies indicated that they had formal strategies in place for various business functions, only 13% specified that they had a specific strategy for innovation. Formal lean manufacturing strategies (22%) were the more popular, followed by those devoted to NPD (13%). The popularity of lean manufacturing strategies may again be attributable to the economic climate and Enterprise Ireland’s focus on improving such practices in Irish food companies in recent years. When investigated further, having a formal innovation strategy in place was not found to be significantly related to engagement in any form of technological innovation. This suggests that innovation in Irish food SMEs occurs in an *ad-hoc* manner, and may be similar in nature to ‘hidden innovations’ as described by NESTA (2007). In this, innovations are not identified by the traditional methods, which may be true in this case also. However, a formal NPD function and a dedicated NPD facility were found to be significantly more prevalent in companies that had a formalised strategy and an innovation strategy in particular (see table 7.11 which compares the number of companies with NPD facilities and functions who indicated they had innovation strategies to the average for the all the companies. This gives an indication of whether there is a higher prevalence of innovation strategies in companies with dedicated NPD resources). Asheim and Coenen (2005) suggest that for radical innovations to occur, more formalised knowledge generation mechanisms are needed. This opinion may contribute to the explanation of the high rates of incremental innovations in this sample. As the question regarding the presence of formal strategies in the company was in an open-ended format, as opposed to the closed-ended format of the rest of the questions discussed, the results must be considered preliminary in nature.

Table 7.11 Comparison of companies with formal general strategies and formal innovation strategies in place for companies with NPD function and NPD facilities

	NPD function in place			**NPD Facility**		
	Yes (n=76) %	**Total (*n*=118) %**	**χ^2 (*p* value)**	***Yes (n=54) %***	**Total (*n*=98) %**	**χ^2 (*p* value)**
Formal strategy in place (*n*=40)	75.4	62.4	9.79**	75.0	57.1	18.31***
Innovation strategy in place (*n*=17)	94.1	61.3	7.42**	82.4	53.4	5.40*

***Significant at 0.1%, **significant at 1%, significant at 5%

In agreement with Lloyd (1998), Daghfous (2004) and O'Regan *et al.* (2006), interviewees in the first round of semi-structured interviews highlighted the importance of a culture for innovation in facilitating change in firms. This led to the inclusion of 'firm culture' as a separate variable in the modified model of absorptive capacity that was used as the basis of the questionnaire. Cooper *et al.* (2004) proposed a number of key elements that contribute to a successful culture of innovation, including a supportive environment for innovation, an open communication culture, availability of resources for creative work and rewards for staff. In this sample, the majority of food companies were assessed to have a medium level of innovation culture (62%), with only a tenth appearing to have a high level of receptivity to innovation (method for assessing culture is described in Chapter Five). A higher innovation culture was found to be positively associated with engagement in technological innovation [$F(1, n=117)=10.0$, $p<0.01$]. When looking at the difference between groups in more detail, a significant positive association was seen for product innovation [$F(1, n=112)=11.3$, $p<0.001$], but not for process [$F(1, n=106)=2.1$, $p>0.05$] or packaging innovation [$F(1, n=107)=3.5$, $p>0.05$] (table 7.12, which compares the level of a positive culture for innovation within companies with the occurrence of different types of technological innovation). Culture was also found to be significantly different across sectors, with the prepared consumer foods sector ($\bar{x}=3.64$) observed to have a significantly higher openness to innovation, compared with the meat ($\bar{x}=3.19$), dairy ($\bar{x}=3.19$) and ‘other’ ($\bar{x}=3.29$) sectors. Culture was not found to be related to strategy for innovation, firm size, engagement in IP protection, market orientation or presence of an NPD function in this sample. However, the importance of ‘openness-to-change’ in an organisation in facilitating technological innovation was evident in the results. This again suggests the occurrence of ‘hidden innovations’ within the food industry, which are not identified by conventional measures. Although it has been traditionally seen as an industry with low levels of innovation (Menrad, 2004; Lagnevik, 2003), this does not appear to be truly reflective of the ongoing levels of innovation in the industry.

Table 7.12 Comparison of the level of innovation culture across different types of innovator

	Low Companies ***n*** **(%)** 26 (22.0) **%**	**Med Companies** ***n*** **(%)** 79 (62.2) **%**	**High Companies** ***n*** **(%)** 13 (10.2) **%**	**Total Companies** ***n*** **(%)** 118 (100.0) **%**	**χ^2 (*p* value)**
Product innovation	62.5	84.2	92.3	80.5	6.78*
Process innovation	47.8	58.6	69.3	57.5	1.65
Packaging innovation	34.8	65.3	61.5	58.3	6.73*
Technological innovation	69.2	92.4	92.3	87.3	9.80**

7.4.2.5 Market orientation

Nearly three quarters of companies (72%) in the sample indicated that they engaged in market research. This was a mixture of contract and in-house research (see figure 7.14). The most popular applications of market research related to developing new products (90% of companies), packaging (87%), accessing new market segments (88%) and targeting new customers (84%).

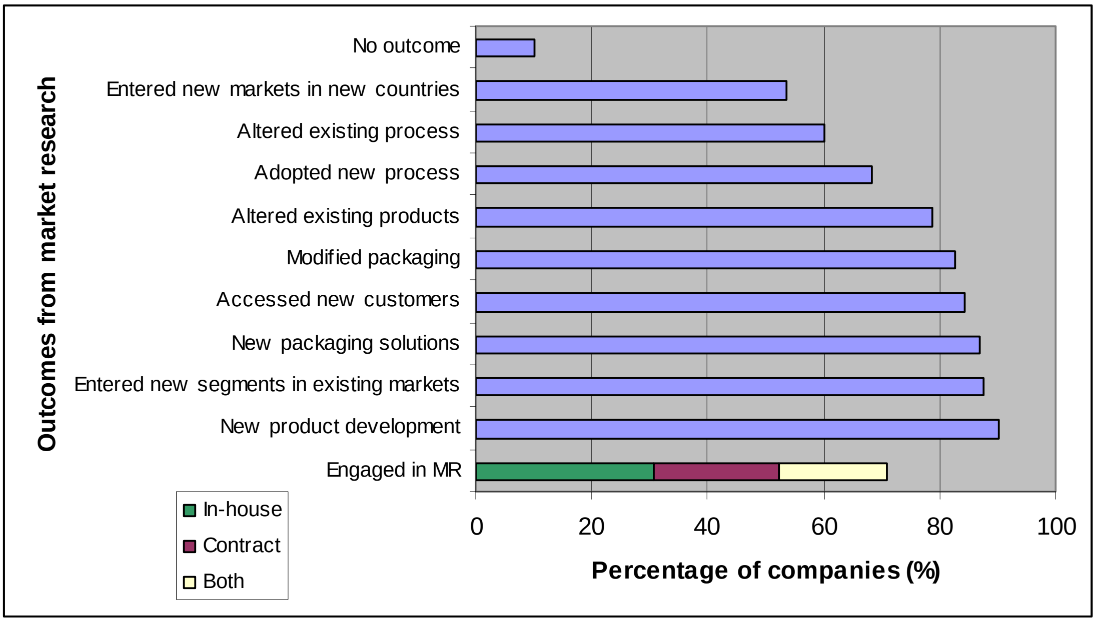

Figure 7.14: Beneficial outcomes of the utilization of market research among the sample of Irish food companies

Batterink *et al.* (2007) and Traill and Grunert (1997) contended that successful product innovation was dependent on strong market orientation. This strategy was also endorsed by the Food Harvest 2020 report (Department of Agriculture, Fisheries and Food, 2010). In this study, significantly higher rates of almost all forms of innovation (except packaging innovation) were documented among companies that conducted market research (see table 7.13). The drivers behind engaging in packaging innovation may be different to those driving the other forms of innovation, and thus again warrant further investigation.

Table7.13 Comparison of companies who engaged in market research across different types of innovation

		Engaged in market research			
		Yes (n=86) %	**No (n=35) %**	**Total (n=121) %**	**χ^2(*p* value)**
Product innovation	Yes	90.7	69.3	84.2	9.18**
	No	9.3	35.7	15.8	
Process innovation	Yes	69.2	37.9	60.7	7.42**
	No	30.8	62.1	39.3	
Packaging innovation	Yes	70.4	48.3	64.5	3.64
	No	29.6	51.7	35.5	
Technological innovation	Yes	55.6	76.7	90.8	7.56**
	No	4.4	23.3	9.2	

***Significant at 0.1%, **significant at 1%, significant at 5%

7.4.2.6 Senior management involvement with NPD

The impact of the involvement of senior management in NPD is not clear-cut in the literature within the context of the food industry. A number of studies have found direct involvement in NPD to be predictive of successful innovation (Kristiansen, 1998; Hoban, 1998); however, Stewart-Knox and Mitchell (2003) contradicted this finding. In this study, managerial involvement in NPD was significantly higher in companies who engaged in all types of technological innovation (table 7.14). The ‘hands-on’ nature of the managerial involvement in product innovation may also be spilling over and positively affecting other types of technological innovation. However, as there is no measure of the success rate of innovations in the current study, these results cannot be compared directly to the previous studies.

Table 7.14 Comparison of senior management involvement in NPD with innovation types

	Management involvement in NPD (n=121)				
	Yes		No		*t*-test
	Mean	SD	Mean	SD	
Product Innovation	4.42	0.67	4.00	0.98	2.69*
Process Innovation	4.46	0.66	4.17	0.87	1.37*
Packaging Innovation	4.50	0.67	4.13	0.84	0.16**
Technological Innovation	4.41	0.68	3.73	1.10	8.58*

***Significant at 0.1%, **significant at 1%, significant at 5%

7.4.2.7 Hypothesis$_2$

When looking at the evidence to support the second hypothesis, a number of the supportive internal factors were found to be more prevalent in the firms engaging in innovation compared with those that were not. The results from the survey also provided an overview of the current innovation capacity of Irish food companies. A high level of post-school qualification was noted in this sample, which has the potential to increase the absorptive capacity of the industry in the longer term. Although the most popular form of training seemed to relate to health and safety requirements, a large proportion of companies also engaged in NPD, innovation and marketing training. Formal strategies for innovation were rare. However, high levels of innovation culture were identified. The importance of culture in driving innovation may have been overlooked until now in relation to Irish food SMEs and is an area of interest for further study, particularly when examined through the lens of the 'hidden innovation' concept. Although, high levels of NPD functions were reported, there was potential to improve the facilities available to this resource. High levels of market research were also reported, with nearly three quarters of the sample engaging in some form of market research.

7.4.3 Other independent variables

7.4.3.1 Intersecting factors

Lane *et al.* (2006) asserted that when sourcing ideas externally to the firm, both the nature of the relationship between collaborating organisations, and the difference in characteristics of the two entities, impact on the success of the venture. In this sample, it was found that nearly half of companies (49%) believed that if their company were to collaborate with another company, both would benefit fairly (see table 7.15). However, the measure employed in this questionnaire to assess the intersecting factors did not fully cover all aspects of this complex association. Furthermore, it was specific to business-to-business interactions and did not address collaborations between industry and publicly-funded research. This relationship was examined in detail in a previous project in Teagasc Food Research Centre (Henchion *et al.*, 2008) and was explored in the closing qualitative stage of this research.

Table 7.15 Perceptions of the fairness of the relationships between collaborating companies in the sample of Irish food companies

	Disagree	Neutral	Agree
	***N* (%)**	***n* (%)**	***n* (%)**
If the company was to collaborate with another company, both would benefit fairly	13 (10.2)	47 (37.0)	62 (48.8)

7.4.3.2 **Outcomes**

In the current climate of economic recession, it is not surprising that a considerable percentage of companies indicated they were focusing on improving efficiencies through cost-cutting (97%) (figure 7.15). Also identified was the importance of developing market share (97%) and new products (92%). Conversely, patenting (27%) and outsourcing activities (37%) were not singled out as top priorities.

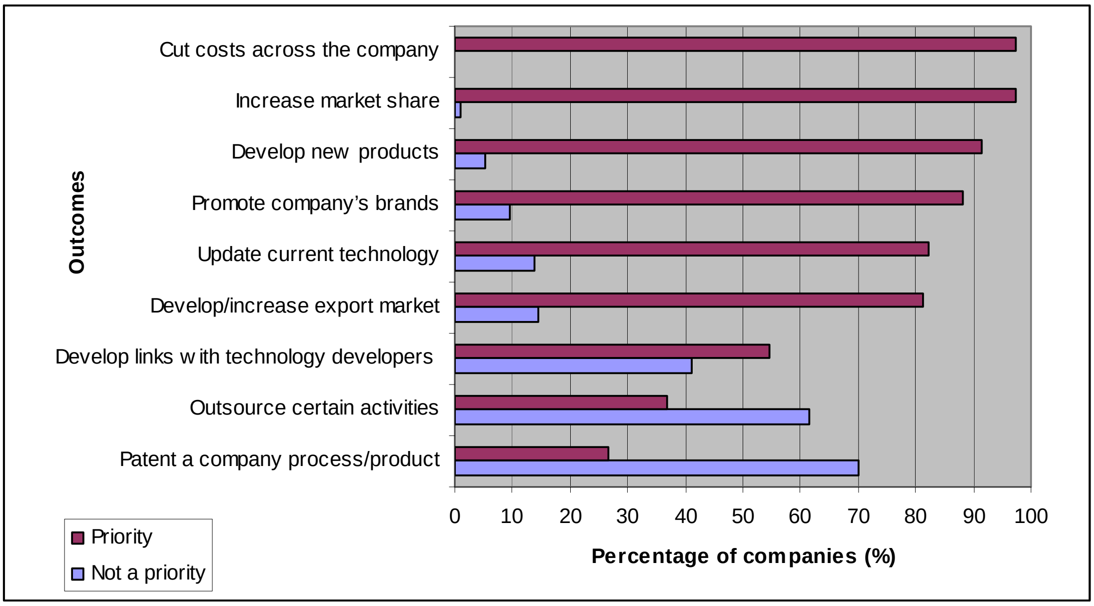

Figure 7.15: Percentage of the sample of Irish food companies prioritising different outcomes from investing in technological innovation. (Companies were asked to give an indication of the level of priority placed on each of nine items from a pre-defined list)

Cohen and Levinthal (1990) opined that the anticipated commercial benefit of investing in a new technology was a major driver of such a decision Similarly in this sample, 'increasing market share' (48%) and 'new product development' (42%) were very popular outcomes envisaged when investing in a new technology. However, the desired selection criteria that far exceeded all others in popularity was that of 'compatibility with current portfolio' (57%). By its very nature, an innovation that is 'compatible with current portfolio' will be incremental, and this has implications for the prevalence of radical innovations in the industry. This finding was also unearthed in a meta-analysis of the diffusion of innovation literature, in which 'compatibility' was one of the most sought after criteria from a new technology (Tornatzky and Klein, 1982). Furthermore, this result is consistent with the opinions of interviewees involved in the first round of semi-structured interviews who cited compatibility with product portfolio, for example in terms of distribution, as integral in the decision to adopt an innovation. Despite Lane's (2006) opinion that developing the bedrock of knowledge within the company should be a priority, the knowledge outcome ‘developing the understanding within the company’ was not favoured by many of the companies (5%). This may be indicative of a short-term view prevailing within Irish food companies, as was previously evident in the first round of interviews, and also found by Traill and Grunert (1997). A short-term view may compromise innovations that are more radical in nature; as such innovations require the development of a foundation of advanced knowledge over time. Without such input, companies may continue to be limited to incremental innovations.

7.5 Testing the hypotheses - Factors influencing absorptive capacity in Irish food companies

The extent of a company’s absorptive capacity will be positively related to:

$H_{3:}$ elevated levels of certain supportive internal factors (e.g. as above)

$H_{4:}$ the degree to which the firm perceives that the business environment has an impact on innovation activities

$H_{5:}$ the level of priority placed on both commercial and knowledge outputs

$H_{6:}$ engagement in technological innovation

The breakdown of the means and proportions of the independent variables across the three levels of absorptive capacity are presented together in table 7.16, along with chi-squared distribution tests of categorical variables and analysis of variance results for continuous variables. In support of hypothesis 3, the factors recognised as playing a role in the development of absorptive capacity were found to be more prevalent in the highest categories of both M1 and M2. When compared with the total sample, higher levels of education generally corresponded with increased absorptive capacity (table 7.16). This is in line with findings by Koc (2007) and Avermaete *et al*. (2004), in which higher levels of educational qualifications were found to correlate with enhanced firm innovation capacity. In terms of *per capita* training expenditure, for M1, there was no significant difference between companies of differing absorptive capacity level. In M2, which is specific to the 'innovators', this pattern was again evident (table 7.16). Avermaete *et al*. (2004) and Freel (2005) found that the most innovative firms had trained more staff and invested more in staff training. However, in contrast to this, Romijn and Albaladejo (2002) asserted that training did not always translate into higher innovative capability; rather such activities were often a vehicle for realising improved administrative efficiencies. The present study found that companies with higher levels of absorptive capacity were significantly more likely to have engaged in training aimed at increasing efficiency [*i.e.* lean manufacturing, change management and supply chain management ($p<0.05$) and driving innovation (*e.g.* NPD ($p<0.01$))] (table 7.16). These results indicate that such companies had an appreciation of both of these beneficial aspects of training.

Cohen and Levinthal (1990) asserted that the existence of a dedicated R&D function was necessary to underpin strong absorptive capacity. In the present study, no significant difference was found in the prevalence of a NPD function across different levels of absorptive capacity. It is possible that the use of the term 'NPD function' as opposed to 'R&D function' was inadequate to differentiate sufficiently between the levels of R&D that were occurring. NPD in food companies varies immensely in terms of level of research involved (*e.g.* from recipe alteration in a 'kitchen' to large-scale pilot plants). By using the proxy for the level of R&D, significant differentiation was seen across groups for M1 (respectively in increasing order of absorptive capacity level, 28.2%, 55.9%, 61.5%, $p<0.01$) (table 7.16).

In agreement with Lloyd (1998), significant improvement in the innovation culture was seen across increasing absorptive capacity groups (M1: respectively in increasing order of absorptive capacity level, 3.23, 3.31, 3.52, $p<0.05$) (table 7.16). As M2 is specific to 'innovators', the extent of the variation between groups may be diminished, and as a result, significant difference would be more difficult to discern. The level of internal communication linkages, the presence of a formalised innovation strategy and direct senior managerial involvement in NPD were not seen to differ significantly between groups. However, companies with lower absorptive capacity (as indicated by both measures) had reduced levels of all three variables compared to the overall sample. Managerial involvement in NPD was not significant across groups. This is similar to findings by Stewart-Knox and Mitchell (2003), who found that the role of the manager in SMEs centred on shorter-term, tactical decisions, as opposed to longer-term, strategic choices. Although this suggests that managers in small firms concentrate on ensuring day-to-day operations run efficiently, as opposed to focusing on long-term projects (*e.g.* product innovation), this is incongruent with the earlier findings that senior managerial involvement in NPD was supportive of innovation. However, this may be related to the nature of the innovation involved, as managers may support the more incremental forms of innovation, as opposed to the longer term development of absorptive capacity required for radical innovation.

Hypothesis 4 aimed to investigate the link between the firm's perception of the business environment and extent of absorptive capacity. For most factors in the external environment, M1 gave better differentiation across groups than M2, and is selected here for further analysis (this may again be due to the exclusion of 'non-innovators' from M2) (table 7.16). In terms of the impact of the competitive environment, the group with the lowest level of absorptive capacity perceived significantly less pressure from retailers, suppliers and customers than the medium and high levels (M1: respectively 2.67, 3.39 and 3.23, $p<0.001$) (table 7.16). A similar trend was seen in the operating environment, as the perceived impact of operating costs on innovation activities was again less in the lowest group than the other two groups (M1:respectively, 2.44, 3.07 and 2.99, $p<0.05$). Similar to the results for antecedents of innovation, for both M1 and M2, the impact of economic environment was not significant ($p>0.05$). The results suggest that firms that perceive pressure from the competitive and operating environment are more likely to be receptive to external sources of information.

The perception of the level of impact from regulation is also in line with the levels of absorptive capacity in firms. In comparison with the overall sample, the companies with the lowest levels of absorptive capacity are significantly less likely to indicate that a high number of regulations impacted on their innovation activities (M1: 51.1% in comparison with 36.6% of the overall sample, $p<0.05$) (table 7.16). While the importance of *HACCP* and *ISO regulations* were evident across all groups, companies with higher levels of absorptive capacity had an increased likelihood of indicating the importance of *nutritional information labelling*, *nutrition and health claim legislation* and *labelling requirements for allergens*. A possible explanation of this is the type of products involved, as companies with higher levels of absorptive capacity may be offering products that are subject to more rigorous regulation (*e.g.* health and nutrition claims legislation) and therefore, feel the effect of such regulations to a greater degree. Additionally, recognition of the value of the knowledge environment was found to be aligned with the observed level of absorptive capacity in Irish food firms. Unsurprisingly, 83% of the firms classified as having a higher level of absorptive capacity, perceived the knowledge environment to be of use to their activities, in contrast to 11% of firms falling into the lower category.

Table 7.16 Means and proportions of independent variables with Chi square analysis of categorical variables and one-way ANOVA between continuous means

	Total		Low		Medium		High			
	Measure 1	**Measure 2**	**Measure 1**	**Measure 2**	**Measure 1**	**Measure 2**	**Measure 1**	**Measure 2**	**Measure 1**	**Measure 2**
Hypothesis 3 – Internal factors									**χ^2 or F value**	**χ^2 or F value**
Qualification Level 1	18.8%	20.0%	30.0%	22.2%	10.0%	16.0%	16.7%	21.6%	5.58	0.55
Qualification Level 2	36.5%	36.3%	33.3%	33.3%	46.7%	36.0%	30.6%	37.8%		
Qualification Level 3	44.8%	43.8%	36.7%	44.4%	43.3%	48.0%	52.8%	40.5%		
Training/capita (€)	694	816	704	2,137	576	1,045	787	458	0.12	2.47
Communication linkages	62.6%	68.4%	51.1%	70.8%	69.4%	78.6%	69.0%	60.5%	4.00	2.66
Firm Culture	3.36	3.38	3.23	3.18	3.31	3.40	3.52	3.48	3.49*	2.63
Innovation strategy	13.8%	15.8%	6.7%	16.7%	13.9%	10.7%	13.8%	15.8%	3.98	0.81
Mgt^. involvement in NPD	90.2%	91.6%	88.9%	87.5%	94.4%	92.9%	88.1%	93.0%	1.04	0.69
NPD function	62.0%	70.2%	48.9%	62.5%	69.4%	81.5%	70.0%	67.4%	5.21	2.48
R&D grant	48.2%	55.8%	28.2%	38.9%	55.9%	53.8%	61.5%	64.3%	9.82**	3.35
Hypothesis 4 – External factors										
Operational environment	2.81	2.83	2.44	2.74	3.07	2.80	2.97	2.89	3.99**	0.15
Competitive environment	3.09	3.18	2.68	2.83	3.39	3.20	3.23	3.35	8.55***	2.95
Economic environment	2.88	2.9247	2.5427	2.6364	2.9500	2.7143	3.14	3.21	2.97	2.59
Regulatory environment – Level1	36.6%	31.6%	51.1%	50.0%	27.8%	17.9%	28.6	30.2%	14.08**	9.13
Level 2	30.9%	30.5%	33.3%	29.2%	38.9%	42.9%	21.4%	23.3%		
Level 3	15.6%	37.9%	33.3%	20.8%	50.0%	39.3%	32.5%	46.5%		
Knowledge environment	44.7%	43.0%	11.1%	40.9%	41.7%	21.4%	83.3%	58.1%	46.03***	9.38**
Hypothesis 5 – Outputs										
Knowledge outputs	3.3%	4.2%	2.2%	4.2%	2.8%	3.6%	4.8%	4.7%	0.48	0.05
Commercial outputs – NPD	37.4%	46.3%	40.0%	33.3%	33.3%	53.6%	38.1%	48.8%	0.39	2.33
Commercial outputs – market share	30.9%	41.1%	24.4%	25.0%	36.1%	46.4%	33.3%	46.5%	1.45	3.42
Commercial outputs – patent	72.4%	74.7%	66.7%	62.5%	69.4%	78.6%	81.0%	79.1%	2.43	2.55
Hypothesis 6 – Firm performance										
Product innovation	79.5%	85.1%	68.2%	75.0%	86.1%	92.6%	85.7%	86.0%	5.42	3.16
Process innovation	54.1%	60.6%	34.1%	54.2%	66.7%	55.6%	64.3%	67.4%	11.14*	1.55
Packaging innovation	57.4%	63.8%	55.3%	58.3%	66.7%	66.7%	54.8%	65.1%	1.86	0.44
Not engaged in technological innovation	10.6%		22.2%		5.6%		2.4%		10.402**	

***Significant at 0.1%, **significant at 1%, *significant at 5% ^Mgt=management

Hypothesis 5, which examined the link between degree of absorptive capacity and priority placed on outcomes from investing in external knowledge, was not supported, as presented in table 7.16 (*p* value >0.05). It is possible that the measures used to assess outcomes were too general in nature. In an effort to investigate this further, desired outcomes from technological innovation were included for discussion in the follow-up qualitative interviews.

The final hypothesis looked at the relationship between extent of absorptive capacity and engagement in technological innovation. For both measures of absorptive capacity, process innovations were less common in the lower groups, with the higher groups (M1: 66.7% and 64.3%) far exceeding the levels of process innovation in the lower groups (M1:34.1%). A significant difference was not found across packaging innovators. As M2 is limited to 'innovators', an analysis of those not engaging in technological innovation was only possible with M1. The results indicate that 'non-innovators' were significantly more likely to have low absorptive capacity levels as measured by M1. This evidence suggests that increasing the absorptive capacity of firms would concurrently increase the predominance of technological innovation. In this way, the thesis supported the hypothesis that a developed absorptive capacity facilities technological innovation in food companies.

7.7 CONCLUSION

The sample of companies who completed the survey was reasonably representative of the Irish food industry in terms of regional spread, size, sector and exporting status. High rates of all types of technological innovation were noted in this sample. Although the product and process innovation rates were higher than the industry innovation rates found by the Community Innovation Survey (Forfás, 2010c), the rates were similar to those reported from two European studies of the food industry

(Garcia-Martinez and Brinz, 2000; Avermaete *et al.*, 2004). Packaging innovation was not investigated as a separate category in any of these studies, and therefore comparison by type of innovation was not possible. In line with results from other studies in SMEs, informal IP protection options predominated in this sample.

When examining the first hypothesis as a unit (investigating the impact of the factors in the business environment on innovation), a complex relationship became apparent, with different factors both driving and constraining innovation. A positive trend towards consumer orientation was evident in the sample, and respondents acknowledged the influence of their customers on their innovation efforts. Challenging business environment factors such as increasing operational costs (*e.g.* energy and wages) and limited availability of credit were indicated to be resulting in pressure to innovate for Irish food companies. In terms of the knowledge environment, the scientifically advanced knowledge of third level institutes may be of particular advantage to those conducting radical process innovations in the industry. When investigating the factors influencing innovation in the sample, packaging innovation repeatedly emerged as different to the other forms of technological innovation and thus warranted further investigation.

In line with the second hypothesis, a number of factors internal to the firm emerged as having an impact on technological innovation rates. Access to a dedicated NPD function appeared to be important for all types of technological innovation, with process innovations particularly benefiting from a higher level of research. Market orientation was again seen to promote product and process innovators, as was a higher density of intra-firm communication linkages. Results suggested that managerial involvement in NPD was advantageous across the board, with all types of innovation increasing in prevalence as a result of higher input. Although, a strategy for innovation did not appear to be particularly influential, a positive innovation culture did appear to be related to increased rates of technological innovation, particularly product innovation. This finding suggests that the traditional measures of innovation may not be highlighting the innovation that is occurring and is of importance to the food industry. Therefore, a sector-specific innovation index (similar to that suggested by NESTA) may be beneficial in future research. Studies such as the current work can provide information for the development of such an index.

When looking at the hypotheses specific to absorptive capacity, the third hypothesis was partially supported, as the factors recognised as playing a role in the development of absorptive capacity were found to be generally more prevalent in firms with higher levels of absorptive capacity. Companies in the medium and high groups had invested in staff with higher qualification levels, than the lowest group. In particular, a culture of innovation has been highlighted as an important building block in firm absorptive capacity. This observation was also made in the first round of interviews with representatives from the food industry in which culture was found to be a vital component of firm receptivity to external information. As a result of such findings, the addition of culture in the modified version of the Lane *et al*. (2006) model was assessed to be justified.

The fourth hypothesis set out to explore the relationship between levels of absorptive capacity and perception of the business environment. The highly competitive nature of the food industry, in conjunction with mounting operating costs and numerous regulatory requirements, may be driving companies to invest in developing absorptive capacity as a mean of facilitating innovation. However, companies with lower levels of absorptive capacity appear to perceive less of an impact from the business environment on innovation. If such companies do not appreciate the environmental pressures necessitating innovation, they may be unaware of the need to change (*i.e*. 'pre-contemplative' as seen in Prochaska *et al., 1995*). This has policy implications, as companies with low absorptive capacity may need specifically targeted interventions that aim to animate companies initially, to ensure they are engaged with the process. Such interventions need to precede the implementation of recommendations on ways to increase absorptive capacity for such companies.

In terms of priority placed on outcomes from investing in external knowledge, the measures applied in this survey were not found to be significant, and as a result, the fifth hypothesis was rejected. The next stage of qualitative research was seen as an opportunity to elucidate measures more relevant to Irish food companies.

With regard to the final hypothesis, the development of more direct measures of firm performance, possible in surveys enforced by legislation (such as the CIS), may demonstrate more definite benefits to investing in absorptive capacity development. However, the data did show that lower levels of absorptive capacity were linked with lower levels of technological innovation, particularly process innovation. A significant difference was not found across packaging innovators, and it is possible that publicly-funded support agencies are not thought to be of value in terms of assisting packaging innovation. The input of commercial sources (*e.g.* retailers and suppliers) may be particularly influential here. The higher proportion of packaging innovators in the group which favour the input of commercial sources (*i.e.* M2 group 2) gives additional credence to this assertion. The factors influencing packaging innovation thus warrant further investigation.

Overall, the model of technological innovation, developed from the literature reviews and the semi-structured interviews, provided an informative overview of the internal and external factors that impact on absorptive capacity in the Irish food industry. When testing the hypotheses, M1 generally identified clearer differences between groups compared with M2. When applying the second measure, the distinguishing characteristics of each level of absorptive capacity may have been more difficult to discern due to the sole focus on ‘innovators’ (and the resultant reduction of variation between groups). The subtle differences between groups may be more easily identified in a larger sample size than was possible in this study.

This survey did not address the intersecting factors that underpin the relationships between industry and publicly-funded research agencies. An investigation of these factors was conducted previously, and the results are discussed in Henchion *et al.*, (2008); these were also investigated in the final qualitative stage of the research. Following the analysis of the postal survey, a number of issues such as this were raised which needed further investigation. These issues form the basis of the semi-structured interview guide, which was used for the final qualitative step of the research.

Chapter 8

Results and discussion- 2- The semi-structured interviews

8.1 INTRODUCTION

A further series of in-depth interviews were conducted in order to provide additional insights into the results obtained in the initial stages of research. This approach was based on the evidence surrounding the benefits of mixed methods, in which qualitative research can elucidate and investigate the relationships discovered initially by quantitative research (Miles and Huberman, 1998; Flick, 2006; Creswell, 2009). Following the analysis of the postal survey, a number of issues were raised which required further clarification and elaboration. These issues formed the basis of a semi-structured interview guide, which was used for the final qualitative step of the research, and are outlined as follows:

- Empirical research, previously conducted by Teagasc and DIT investigated the relationship between the knowledge environment and Irish food companies (Kelly *et al.,* 2008; Henchion *et al. in press* B, Henchion *et al.,* 2008; O'Reilly and Henchion, 2010). As a result, the current research did not focus specifically on the intersecting factors of the modified model of absorptive capacity. However, in order to give a comprehensive picture of the entire process it was decided to include this as a topic for discussion in the final round of interviews
- Similar to findings in the literature, the interpretation of the term 'innovation' was found to be subjective among those operating in the food industry, giving rise to the possibility of several interpretations of the term across survey respondents. Furthermore, when comparing the findings with the results of other related surveys, this cohort reported particularly high levels of 'radical'

innovation. Therefore, an investigation of the interpretation of the measure used to indicate such innovations was thought to be appropriate

- A number of anomalies associated with packaging innovators were detected which warranted further investigation. For example, the factors which seemed to be motivating involvement in product and process innovation did not transfer to packaging innovators (*e.g.* the competitive or operating environment). Furthermore, internal factors which seemed to be facilitating process and product innovation did not appear to be having the same effect on packaging innovators (*e.g.* conducting market research, innovative firm culture)
- The measures to assess the priority of the outcomes from technological innovation used in the survey did not seem to be aligned with those used in food companies in Ireland
- For logistical reasons, the first round of interviews was conducted in Dublin and the surrounding region. In order to control for any geographic bias that might have arisen as a result of this, an effort was made to ensure that the majority of the second round of interviews were located outside this region
- The time-period between the first round of interviews and completion of analysis was approximately one year. In the interim, the Irish economy faced a number of challenges including a deepening worldwide recession, recapitalisation of the Irish banking system and the involvement of the European Central Bank and International Monetary Fund in the financing of the country. Due to the dynamic nature of the business environment, it was important to ensure that the environmental factors initially identified and assessed in the questionnaire remained relevant after the elapsed time, and that no major issues had emerged in recent months

Interviewees were drawn from both industry representatives and from agencies supporting the industry. Each of the points outlined above are discussed in turn in this chapter.

8.2 THE INTERSECTING FACTORS OF THE MODEL

The modified Lane *et al.* (2006) model included two intersecting factors which underpin the relationship between industry and publicly-funded research providers. The first factor related to the nature of the relationship between collaborating organisations, and is aligned with findings by O'Reilly and Henchion (2010) that identified personal relationships between researchers and industry as a key mediating factor for the success of technology transfer. The second intersecting factor focused on the difference in characteristics between researchers and industry, with a number of authors believing that similarity in terms of learning level and organisational characteristics (for example, culture, structure, time-lines) facilitate successful collaborations (Mowery *et al.* 1996; Lane and Lubatkin, 1998). As the questionnaire did not directly measure such intersecting factors, new questions to dissect the relationship between industry and publicly-funded research providers were included in the final round of semi-structured interviews.

In agreement with the findings of Menrad (2004) in the German food industry, Irish support agency representatives affirmed the importance of a mature company absorptive capacity. They asserted that it was a vital component of the transfer of knowledge between publicly-funded research institutes and SMEs. Companies with low absorptive capacity were thought to be unable to "identify with" or "see the potential from" publicly-funded research. This low level was seen as problematic in many aspects of business that contribute to innovation, from availing of supports and grants, to optimising market research:

> *Who is going to interpret the [market research] data for them and apply that interpretation to their business? (Support agency representative 1)*
>
> *There is a need to be technically savvy and business savvy to get grants and supports. (Support agency representative 2[27])*

A number of the support-agency representatives unprompted directly cited the term “absorptive capacity”. While the industry representatives did not make direct reference, they did provide examples of how a developed absorptive capacity had benefited their businesses:

> *[When describing the adoption of a novel process innovation] We based the project in UCC first. And we had our own researchers working on it. And then we brought it through to launch. (…) We had a NPD resource at that time. (Industry representative 2)*
>
> *It is vital to be [active in NPD]. You couldn’t supply the retailer without that resource. In a bad week here, we could get 20 ‘own label’ briefs - And you might be given only two weeks to get back with the product sample and prices etc. You couldn’t do that [meet these timelines] without that resource. (Industry representative 2)*

When describing the level of human capital involved in such NPD functions, “food science graduates” with previous “related experience” were cited. This suggests that while the actual term ‘absorptive capacity’ is academic in nature, the importance of having a certain basal infrastructure in place to facilitate absorption of external knowledge is recognised by both support agencies and a proportion of industry.

However, support agency representatives perceived that there was generally a low level of absorptive capacity in Irish food SMEs, and as a result, innovation was thought to be suffering:

[27] In this chapter, the nine interviewees were not coded numerically (as in Chapter 5). This was due to the unique roles of a number of the support-agency representatives and the distinctive nature of the companies involved. It was felt that the specific focus of certain quotations could allow for easy identification of respondents and would breach the promise of confidentiality pledged.

There isn't forward thinking, because they don't really have the mechanisms to know what is innovation. (Support agency representative 5)

In contrast to SMEs, larger companies were thought to contain the resources necessary to obtain benefit from publicly-funded research. The infrastructure which enabled uptake and further development of this research was felt to be well established in such companies, particularly in the dairy industry. A number of the support agency representatives believed that the diffusion of postgraduates from the Teagasc Food Research Centre, Moorepark, into the dairy sector had strengthened the absorptive capacity of the sector as a whole. This network of graduates was believed to have given rise to an effective dissemination tool, in which the capacity of industry to benefit from ongoing research was optimised (a similar situation in which the German marine sector had developed its absorptive capacity through a pipeline of graduates was also cited by a support agency representative). Interviewees attributed this partly to the establishment of a network of contacts with established links to the base organisation, also termed social capital (Kallio, *et al.* 2010). The OECD (Grootaert, 1998) defined social capital as "the norms and social relations embedded in the social structures of societies that enable people to co-ordinate action to achieve desired goals" and it is thought to be advantageous when developing collaborations between organisations. Moreover, it has also contributed to be an enhanced ability to recognise the potential from research; Romijn and Albadejo (2002) found that having a SME manager with prior experience in a scientific environment was conducive to producing innovations with higher levels of novelty. A higher level of value placed on external sources of innovation was also found to be associated with engagement in technological innovation in the results of the survey (in particular product and process innovations). Furthermore, in other sectors, examples were provided by interviewees of companies in which highly qualified employees had readily engaged with projects; this was again attributed to their finely honed ability to visualise the potential benefits for their company.

Those with previous experience in the larger dairy companies were also believed to be better equipped to set up individual businesses and maximise the available supports:

> *They are generally people coming from previous employment in some of the larger dairy companies. (…) People who have a very strong business [sense]. A lot of experience in the commercial world. In the dairy commercial world. They probably would have a deeper knowledge of the science and technology as well. They would approach Moorepark as the research provider. (Support agency representative 4)*

An example of the importance of related experience in practice was provided by one of the SME industry representatives who revealed that their NPD employee had prior experience in one of the larger dairy companies. Despite the company being in a different sector entirely, the cross-over of skills associated with NPD was evident.

Recognition of the importance of a “pipeline” of “well-rounded” graduates diffusing into the food industry was often contextualised in terms of the resultant increased absorptive capacity:

> *[Germany] produces very knowledgeable well rounded graduates, who go into the industry, and then the ability of the industry to absorb new ideas is strengthened, whereas in Ireland….. [this is not the case for the seafood sector in particular] (Support agency representative 5)*

The significance of the Food Institute Research Measure (FIRM) programme in developing high levels of human capital was also referred to. However, a number of concerns were raised by both industry and support agency interviewees relating to a perceived low level of business skills in the highly technically qualified graduates:

> *When they [postgraduates] get out there, they haven’t been given the skills in terms of business, marketing, branding. (Support agency representative 5)*
>
> *They have no experience when they come out of graduate courses or PhDs (Industry representative 2)*

The importance of graduate development schemes, which attempt to breach the gap between scientific and business capabilities, was stressed (*e.g*. the FIRM Food Graduate Development Programme established in 2008). The potential of including industry placement as part of the FIRM PhD programme was also suggested as a means of addressing this issue. Feedback from the initial round of interviews further developed on this theme, with industry interviewees highlighting the importance of tacit issues (*e.g.* inter-personal skills and business acumen), citing an ability to "think strategically" and have "credibility to deal with customers" as more important attributes than qualifications *per se*. Long-term, the infusion of "well-rounded" graduates into all sectors of the food industry was seen as a vital means of increasing industry-wide absorptive capacity. In doing so, the uptake of publicly-funded research would be facilitated, and its impact on innovation maximised.

Despite the evident dedication of resources to NPD in the companies interviewed for the current study, support agency representatives speculated that such internal structures (which facilitate innovation) were absent in the majority of Irish food SMEs. In the survey, the preponderance of companies indicated that they had a NPD function; however, the level of NPD was questionable. Due to the small scale of the vast majority of the SMEs, the allocation of resources to a dedicated technical function was thought to be unrealistic.

> *There definitely wouldn't be a dedicated NPD person in the smaller companies. (Support agency representative 2)*

> *It depends on how large they are…It would be very difficult to justify a resource for technical [sic]. You know? (Support agency representative 1)*

The long-term benefits of collaborating with research organisations may not be taken into account when making resource allocation decisions, as resources are currently limited due to the situation in the wider economic environment, which creates a tendency to focus on short-term survival. This is in contrast to the MNCs, which were cited to devote resources specifically to such development activities ("dedicated people in many different departments like NPD, technical, regulation"). The non-dedication of resources to NPD was previously highlighted as problematic by a number of authors (Shefer and Frenkel, 2005; Supnithadnaporn and Jung, 2007; Vieites *et al.,* 2011).

As a means of addressing the inability to allocate resources to development activities, due to resource constraints, SMEs were believed to resort to multi-tasking *("People kind of do a bit of everything").* Due to its inherent flexibility, this option can provide an effective way of linking different functions and disciplines. However, Triall and Grunert (1997) warned that a lack of focus caused by an abundance of projects and too much other work may interfere with the potential returns from such a strategy. Furthermore, Traitler *et al*. (2011:65) cautioned that such development projects were most likely to be assigned lower priority ("because people allocate their time based on priorities and job pressure, innovation tasks are typically postponed"). Evidence of this emerged in conversation with the industry representatives, in which immediate tasks, such as replying to briefs from retailers, were given priority over longer-term objectives.

> *It wouldn't be like what universities would be doing, it would be more dealing with customer and new products that would have to be launched quite quickly. (Industry representative 1)*

On this point, Traill and Grunert (1997) contended that innovation was facilitated by the flexibility intrinsic to SMEs arising from low level of bureaucracy, commitment and motivation of managers and lower overhead costs for innovation. Indeed, in the survey, companies reported low levels of formal strategies. In contrast, the rigid strategies which can develop in larger companies over a period of time have been found to be detrimental in the development of new products (Brockman *et al.,* 2010; Camisón and Forés, 2011; Song *et al*., 2011). Evidence of such rigid strategies emerged in the interviews, with support-agencies citing incidences of MNCs having "very strict structures for reporting" and desiring everything to be "by the book".

In accordance with Nooteboom (1994) and Batterink (2009), this evidence suggests that the supports necessary for innovating SMEs differ vastly from those required by larger companies:

> *For them [the SME] they don't have the resources like a large MNC [to innovate] so they almost have to be, and I don't say this in a derogatory manner, 'hand-held'. (Support agency representative 1)*

Comments indicated that an integrated system of support was thought necessary to better facilitate innovation in SMEs:

> *[SMEs] need support for the whole '360 degrees'. (Support agency representative 1)*

Similar to results from the questionnaire, input from different agencies was appreciated by companies at different stages and types of innovation. Although, support agency representatives also cited prior experience in the sector of interest as an important factor in the future success of support, with an ability to understand all aspects of the business deemed imperative:

> *[SMEs] Need someone with 10-20 years experience to help. The support is start- to-finish, and needs input by someone along the way who can talk the language as required. (Support agency representative 7)*

However, a more effective way of supporting innovation may be to assess the level of absorptive capacity currently in the company, and building on this assessment, provide a more targeted intervention. Cohen and Levinthal (1990:128) hypothesised that the process of absorptive capacity occurred sequentially in three steps, via recognition of value (of external information-technology), assimilation of relevant parts into the business and translation of resulting know-how into a commercial return. In the survey, certain organisations perceived to provide more effective support at the different stages of this process. Similarly, in this round of conversations, some of the support agency respondents suggested that while relevant information was available, for some companies it was the inability to apply this information to their current business activities that is problematic:

> *Who is going to interpret that data for them, and apply that interpretation to their business, and what is actually going to work for them? (Support agency representative 1)*

In other companies that had invested in developing their ability to source ideas, problems arose in the practical and technical implications of integrating the innovation into current practices:

> *Companies are increasingly phoning me saying "I have seen a product in France. I want to know how you make it" (Support agency representative 5)*
>
> *They need someone who has expertise across all the aspects of setting up a process or putting in a new project. (Support agency representative 7)*

Alternatively, a third subset of companies also became apparent. In these companies, an evolving level of absorptive capacity was evident from the prior involvement of research agencies in their innovation efforts. For these companies, it appeared that it was the ability to get commercial return from innovations that was proving difficult. One of the industry representatives provided an example of a research project which "had gone so far" with the help of a support-agency, but had required international help to facilitate scale-up and commercialisation:

> *When you are looking at things, what we are looking at [sic]. The processes would have come out of completely different industries that wouldn't be known in Ireland. The place there [in India] had experience dealing with the paper industry and seaweed extractions and guar gum. So, there were a lot of things that wouldn't be known in Ireland. (Industry representative 1)*

Of the currently available supports, Bord Bia and BIM trade missions were mentioned by industry representative as the source of the idea for a number of recent innovations (examples of new-to-market and new-to-company process and products were provided by interviewees. However, these have been omitted in order to maintain confidentiality). Enterprise Ireland, TLIs and Teagasc were cited in terms of being supportive “for the research stages” and in developing the innovation in-line with current company activities. In this round of interviews, no agency emerged as particularly valuable in terms of commercialisation of innovations; however, within the survey, a quarter of respondents perceived Bord Bia to be valuable in this respect. Targeted support of innovation efforts for companies at different levels of absorptive capacity may maximise return from such an investment. Furthermore, improvements in the type of support provided to companies attempting to commercialise innovation efforts presents an opportunity for support agencies.

Despite the investment in research in agri-food through the NDP [(2000-2006) and (2007-2013)], a number of support agency representatives felt that such targeted development supports had not being prioritised in recent years. Conversely, investment had been directed towards less applied (“high-science”) research. However, both industry and non-industry interviewees commented on a recent realignment towards more applied research support in the last year.

> *It [the relationship between industry and research organisations] did suffer a little bit over the last decade or so - when there was an expansion in public-funded research, due to FIRM. That obviously benefited our research base enormously. But sometimes we were a little bit distant from the applied research. But that is being addressed now, and recent calls have been more applied in response to that. (Support agency representative 6)*

> *It [the nature of the available support] is changing. It was not good before, because I think the universities and [research institutes] were just concentrated on the next phase of EU funding and drawing that down, you know? That was their most important ‘revenue stream’, let’s call it. But I think it is changing. (Industry representative 2)*

The importance of a ‘gate-keeper’ as the company’s interface with the external world, as suggested by Cohen and Levinthal (1990), was also evident from responses.

The gatekeeper appeared to have a role, both in identifying ideas with potential application to the business, and in disseminating the knowledge back to the company:

> *[The idea for a radical innovation] came from us. Actually, back in 2002 or 2003 I was on a US study trip organised by Bord Bia. The concept had been launched over there then. We actually got RTI[28] funding from Enterprise Ireland. We based the project in UCC first, and we had our own researchers working on it. And then we brought it through to launch. (Industry representative 2)*

Further to this, the first round of interviews also highlighted a number of incidences of individuals bringing ideas back to the company from trade conferences which went on to become successful technological innovations. This finding may also have application for the improvement in the success of collaborations between research and industry. As good personal relationships with industry were identified as integral to the success of technology transfer, identifying and developing such connections with company gatekeepers would facilitate this process. Building on this evidence, the concept of a gatekeeper may have considerable potential for food SMEs in Ireland. However, this may limit the absorptive capacity of the company to the capacity of the selected 'gate-keeper'.

Support-agency representatives in both rounds of interviews stressed the importance of a "culture change" in industry, in which an increased recognition of the importance of collaborating with other companies or support-agencies prevailed. However, respondents acknowledged that "there [was] a seed of change in that area". In particular, industry and support agency interviewees contended that there was increased collaboration between companies on industry-wide issues [e.g. Guideline Daily Amounts (GDAs), salt reduction, or saturated fatty acid reduction:

> *The only way you can discuss such things [as GDA's] is to get together. It's [sector advocate meeting] very much legislation based and media [perception based]. It also facilitates salt reduction programmes, because unless the whole industry agrees to do it, you are going to lose competitive advantage. So nobody would do it. So it's a forum*

[28] RTI = Research, Technology and Innovation

for doing all those kind of things. So it facilitates the FSAI and that type of thing. (Industry representative- first round interviews)

However, they attributed this to such issues being more amenable to collaboration than competitive issues:

I wouldn't have the freedom to go and discuss like [sic] very new innovations with other companies (industry representative – first round interviews)

A central premise of optimising the association between industry and publicly-funded research providers is the ability of the two entities to communicate; commonalities in language facilitate this. Respondents were of the opinion that a mature absorptive capacity resulted in the lowering of "the language barrier", and enabled companies to better comprehend the outputs from research. The exact nature of this "language barrier" was a contentious point, with doubts as to the lack of absorptive capacity in SMEs vying with misgivings about the overly technical languages used to present the information by researchers. Support agency respondents also cited the usage of "fancy" terminology as problematic during collaborative projects, and warned of the possibility of alienating clients ("getting peoples' backs up"). An example of the disharmony between academic language and that used by industry is provided in the quotation:

Do we have a culture for innovation? (Laughs) I think it depends on the Powerpoint presentation you are doing, what culture you have (Industry representative 2)

Here, the academic concept of a 'culture for innovation' was evidently incongruent with the terminology used in the company, despite being a company involved in both radical and incremental innovation. A number of interviewees suggested that tailoring the language to the audience in question (*e.g.* artisans, small companies) would be a more effective mode of communicating research outputs, and possibly facilitate uptake of research by SMEs. This point is further developed in the next section when looking at the interpretation of the term ‘innovation’ by industry.

In addition to dissimilarity in language used by academia and industry, the issue of the difference in expectations (*e.g.* time-lines) was highlighted as contentious. On the one hand, support-agency representatives cited the pressure that arose from companies requiring results “on the button”. Conversely, industry felt that “things move relatively slowly” when research institutes were involved. This is in support of previous findings by O’Reilly and Henchion (2010), in which the “pace” and “high expectations” of industry created friction in collaborative projects. They attributed this finding in part to the difference in performance measures for researchers and for industry, as was discussed previously.

8.3 THE INTERPRETATION OF THE TERM ‘INNOVATION’ AMONG THOSE OPERATING IN THE FOOD INDUSTRY

The strategy employed in the questionnaire to distinguish between levels of innovation, and to account for the subjective nature of the term, ‘innovation’, was the same as that employed by the European Community Innovation Survey (as implemented under the Commission Regulation (EC) No 1450/2004 in accordance with the OECD Oslo Manual and carried out bi-annually in Ireland by Forfás). The first option (‘new-to-firm’) was used to account for innovations of an incremental nature. Innovations that were more radical were represented by the second option (‘new-to-industry’). However, high levels of ‘radical’ innovation were reported in the current survey (‘new-to-industry’ product innovations, 42%; ‘new-to-industry’ process innovations, 14%). This is at odds with results from the CIS, in which lower levels of ‘new-to-market’ innovations’ were reported (‘new-to-market’ innovations: small indigenous firms, ~12%; medium-sized indigenous firms, ~22%). As a result, it was decided to investigate the interpretation of 'innovation' within the opportunity provided by the second round of semi-structured interviews.

The first notable subject of discussion during the interviews was the difference in perception of 'innovation' between those based in the research institutes and in industry. The academic interpretation was felt to be "over-philosophised" and somewhat removed from what industry understood by the term. Indeed, the word itself was referred to as a "public service term or a consultants' term", which could induce a negative reaction in industry:

> *When you say 'innovation', a lot of them [industry] can get their backs up. Because if you have someone in public service going into a factory (…), saying, (…) I am the (…) innovation coordinator and I am going to show you how to be innovative….. (Support agency representative 5)*

> *You can get a lot of people annoyed when you say 'innovation'. (Support agency representative 2)*

Support agency representatives contended that for those working in the food industry, innovation was a more pragmatic concept that incorporated all aspects of the business (faster response times and accessing new markets):

> *Their [industry's] definition of innovation encompasses everything. Not just product development, [but also] lean manufacturing techniques, ability to respond fast to the market, being in touch and on top of the market. (Support agency representative 5)*

> *They would have a hands-on appreciation of innovation. In terms of recipe development, or make [sic] procedure, or actually having to develop their plant…their production plant or so on. (Support agency representative 4)*

The importance of using current resources to 'add value', as described by Buxton (2005), was also evident in companies:

> *Innovation isn't about coming up with the fancy product; it is about coming up with the one that will sell. (Industry representative 2)*

Furthermore, industry representatives provided a broad spectrum of examples of innovation, from research-intensive projects and large capital expenditure on new process technology, to flavour changes and line extensions. This approach is similar to that taken by Schumpeter (1950) and Porter (1990), in which all aspects of the business are included. Nevertheless, differentiating between incremental and radical innovation was a contentious issue. Due to the perceived “all-encompassing” nature of innovation, interviewees felt that this was a difficult distinction to make. However, specific vocabulary, such as the term “blue-sky”, was used in association with the concept of radical innovations. In addition, support from organisations (in particular Enterprise Ireland) in terms of funding was also seen as a marker of more radical innovation. Interviewees also cited “research”, “large capital expenditure” and “intellectual property outcomes” as criteria for being termed ‘radical’:

> *Where you have a very large capital investment from the company up-front, and a very large capital investment (…) up front from (…) from Enterprise Ireland: that tends to be more high-tech. It tends to be more research driven. And it tends to be more intellectual property driven. Maybe with the prospect of licensing out information and technology generated in the project. (Support agency representative 4)*

The predominance of incremental innovation, evident in the literature and the survey results, shone through again in these interviews (*e.g.* “producing the same product with a new sauce, or low fat sauce” or “taking the existing machine and using it to make them the same as what [sic] they are producing in France”). These innovations were not based on extensive lab-based research, but focused on small changes to current practices, similar to the interpretation of innovation described by Buxton (2005):

> *It [product innovations] wouldn’t be like what universities would be doing. It would be more dealing with customer and new products that would have to be launched quite quickly. (Industry representative 2)*

The length of time required to bring an innovation to market may also impact on the level of novelty associated with the innovation. Incremental innovations seem to be those that could “be launched quite quickly”. In contrast, radical innovations may be developed over an extended period of time, with one industry representative describing a radical innovation as a “pet project” that he has been following up over a number of years. However, these ‘radical’ innovations were thought not to be best suited to the food industry in comparison to other industries:

> *[Innovation] is not having a white coat on inside in a lab. Not in our business, whereas maybe in the computer business it could be different. (Industry representative 2)*

> *Innovation can sometimes mean blue sky stuff and brand new concepts. But I imagine for the [food] industry, innovation it is just remaining competitive from a marketing point of view. (Support agency representative 5)*

Both industry and non-industry deemed marketing innovations, as discussed by the Food Harvest report (Department of Agriculture Fisheries and Foods, 2010), to be integral to incremental technological innovations:

> *Not necessarily doing new things with soft drinks, but maybe like a flavoured water. You know? As opposed to adding in or fortifying the product. You know? Doing that sort of thing. It would be more, ‘what does the consumer want?’ (Support agency representative 1)*

> *So! Innovation isn’t about coming up with the fancy product. It is about coming up with the one that will sell. At the right price. Giving the retailer their margin. Giving the consumer value for money. (Be)cause [sic] they won’t buy it if it is not value-for-money. And hopefully getting a margin for yourself at the end of the day. (Industry representative 2)*

> *I think we would like to describe ourselves as [having] a customer-focused culture. And then as innovation fits into that, we are innovation-focused. But our primary focus is on the customer. (Industry representative 2)*

Incremental innovation was recognised to be widespread, and support agency interviewees expressed concern over this aspect as being detrimental in terms of establishing an innovation culture. These respondents were particularly apprehensive regarding the practice of “me-too” innovations, which were thought to pervade the industry. This tradition of ‘following the market’ was not thought to be beneficial over the long- term.

> *Reverse engineering is following the market. The innovation culture is lost. You are just copying (…)We need to have an innovative component in all research (…), so we are trying to solve that immediate need and trying to predict where they [the market] are going to go next. (Support agency representative 5)*

In contrast, industry interviewees justified the more immediate benefits of incremental innovation for their company:

> *Now they [product innovations] wouldn't have been huge innovation, but 50% of our sales are coming from products that we did not have on the shelves 10 years ago. (Industry representative 1)*
>
> *Well, our key customers - and that is the most important thing - they see us as being innovative. And it is always a critical criteria that you are measured on. (Industry representative 2)*

This indicates that a short-term view is currently prevalent within the Irish food industry. However, focusing on short-term survival, through such incremental innovations, may also be a more pragmatic approach to managing the current dynamic economic climate. This was a contentious issue, with some interviewees contending that innovation was relegated in company strategy due to the current economic challenges:

> *While these things are very important, they [food companies] are not necessarily dedicating resources to it [innovation] at the moment. It is 'head down'. Motor ahead [sic] with getting it out. (Support agency representative 1)*

However, in opposition to this viewpoint, the majority of companies in the survey indicated that they had engaged in innovation in the last three years. This suggests that companies are using a broad definition of innovation with all aspects of change within the company incorporated. This indicates that companies have a similar interpretation of innovation to the 'hidden innovation' concept described by NESTA (2007), in which innovations were not necessarily identified by the traditional innovation measures, but were ongoing in the industry.

Following the previous discussion, the definition of 'radical' innovation used in the questionnaire was called into question. The use of the terms 'new-to-market' and 'new-to-company' may not have provided sufficient differentiation in terms of the level of innovation. In support of this, one example from an industry interviewee described an innovation he considered to be incremental, which was in fact ‘new-to-market’. The possibility of false positives (*i.e.* picking up incremental innovations which were ‘new-to-market’) explains in part the high levels of radical innovations that were reported in the sample of food companies surveyed. Therefore, a more sophisticated indicator of truly radical innovations would be beneficial in future work. As the interviewees cited ‘research’, ‘input from EI’ and ‘intellectual property protection’ as common markers for more radical innovations, a potential proxy could build on this. A similar proxy was used in the questionnaire to differentiate between levels of NPD (*e.g.* companies who indicated that they were involved with Enterprise Ireland R&D grants were assumed to have a higher level of R&D ongoing than those who had a NPD function but were not involved with EI). This proxy was found to be useful in distinguishing the level of absorptive capacity in companies, with a significantly higher prevalence of engagement with EI R&D grants in companies with elevated levels of absorptive capacity (as per M1). A means of differentiating between levels of innovation would facilitate more targeted support of innovation in food companies.

8.4 THE PECULIARITIES ASSOCIATED WITH PACKAGING INNOVATORS

During the course of analysing the survey of Irish food companies, a number of anomalies were identified relating to packaging innovators. The drivers which motivated those engaging in product and process innovations did not appear to transfer to packaging innovators. In addition, internal factors which facilitated the other forms of technological innovation did not seem to affect packaging innovations in the same way. In order to elucidate the factors perceived as pertinent for packaging innovators, interviewees in the second round of in-depth interviews were questioned on this area.

Drivers common to the other forms of technological innovation resurfaced during discussion with interviewees, with “legislation”, “retailers” and the “importance of the consumers” coming to the fore. The significance of the consumer was felt to particularly pertain to customs surrounding the way in which certain products were traditionally packed (*e.g.* fruit juices are traditionally in Tetra Pak as opposed to cans in Ireland). An effort to follow consumer trends was also explicitly expressed as a driver of packaging innovation. An example given by one interviewee was the consumer shift from canned beverages to PET[29] plastic bottles over the last decade due to increased convenience (*i.e*. bottles are resealable). In addition, an interviewee indicated that it was customary practice for food SMEs to bulk buy packaging (“for a number of years at a time”). However, changes in legislation can necessitate label modifications (*e.g.* health claims must now be cleared by EFSA before being printed on products). As a result of this, from a regulatory perspective, it is important that there is a sufficient lead-in-time for upcoming legislation. Furthermore, it is important that companies keep themselves updated on forthcoming legislation changes to ensure packaging is in accordance with the requirements. Adapting packaging in order to facilitate emergence into new markets was also highlighted as a reason to innovate in this area (*i.e.* a longer shelf life achieved through a packaging innovation can facilitate accessing more geographically disparate markets). Specific concerns relating to packaging also emerged, with managing product characteristics (*i.e.* “stability of the product”) and technological issues (*e.g.* “what fits in the machine”) cited as influential on the type of packaging chosen.

A key issue revealed during the interviews was the importance of the packaging suppliers. This arena was reported to be dominated by a number of international MNCs

[29] PET = Polyethylene terephthalate

(*e.g. Cryolac*). Interviewees maintained that the packaging MNCs provided access to the variety of packaging and level of expertise required by food SMEs in Ireland:

> *[TLIs] wouldn't be as knowledgeable as the company themselves on their own packaging (Industry representative 2)*

Such MNCs were assumed to have conducted the relevant R&D to be able to offer packaging options appropriate to food companies in Ireland. Furthermore, the ability of such companies to provide a complete service was recognised:

> *They [packaging supplier] sell the machine. They sell the trays and the film, all as one product offering. (Industry representative 5)*

However, a number of interviewees expressed apprehension that some food companies lacked the capacity to "understand the capabilities of technology" and may benefit from an impartial support service that would assess their needs and provide unbiased guidance. Such a service was not felt to be currently available in Ireland and could potentially be provided by support agencies. Additionally, a number of support-agency representatives cautioned that food packaging was not on the present publicly-funded research agenda:

> *At the moment we don't have a research programme on it (…) we are not doing anything in terms of new types of packaging. (Support agency representative 3)*

This was despite a number of FIRM funded projects in the area (*e.g.* Smart and active packaging in the food industry-UCC, DCU, TFRC, Ashtown, UCD; Application and development of non-destructive oxygen sensing packaging technology, UCC). Other interviewees stated that packaging was not a research area of particular priority ("all areas can't be covered") and other areas were more important presently. Indeed, a number of respondents were of the opinion that the expertise provided by the MNCs was sufficient.

8.5 Geographical representation

As the first round of in-depth interviews took place in Dublin and surrounding area, an effort was made to ensure input from other regions in the second round. Among the latter, seven-out-of-nine took place outside of Leinster. No difference in the pertinent issues in the various locations became apparent over the course of the interviews. When interviewees were asked whether proximity to research institutes and third level institutes was an issue, the general consensus was that it did not have a large effect on access to support ("proximity helps, but it is not really an issue"). One interviewee contended that the improvement in the national transport infrastructure was the reason behind this. This finding is interesting when looked at together with the lack of relationship between innovation levels and geographical location that was found in the survey. This gives credence to the assertion that food SME clusters have not formed in Ireland.

It is important to note that a recent analysis of Ireland's innovation performance (Forfás, 2011) highlighted poor ICT infrastructure as a potential barrier to technological product innovation in peripheral regions of the country. This was thought to be particularly pertinent for knowledge-intensive service industries; however, limited access to quality high-speed internet can hinder all firms and interfere with logistics, distribution, marketing, and access to valuable external information (Forfás, 2011).

8.6 Outcomes of technological innovation

When analysing the survey data, no relationship was found between investment in absorptive capacity development and the measures used to gauge priority of outcomes from technological innovation. This is in contrast to opinions in the literature, in which the importance of both the knowledge and commercial outputs were stressed by Lane *et* *al.* (2006) and Cohen and Levinthal (1990). Feedback from the interviews indicated that there may be a lack of formalised desired research targets in many Irish food companies:

> *They [food companies] don't have parameters usually that they want to achieve. More [sic] they want to make a product they have seen elsewhere. (Support agency representative 5)*
>
> *We [the company] try it and see [what happens], as opposed to specific parameters (Industry representative 1)*

While companies demonstrated an interest in "expanding market share", "getting into new markets", developing "new lines" and "new products", formalised target research measures were not thought to be widespread in food SMEs. This may have contributed to the lack of significant difference found when comparing the outcomes prioritised for companies with different levels of absorptive capacity as discussed in the previous chapter.

8.7 The business environmental factors

Despite the lapse of a year since the initial interviews was undertaken, the business environmental factors which appeared to be top-of-mind for this round of interviewees were the same as those identified in the questionnaire. Therefore, the model and the survey can be said to give a representative view of the perception of the current business environment for companies operating in the Irish food industry.

The challenging economic environment again emerged as a highly ranked driver of innovation. The expense of operating in Ireland was also contentious, with Ireland deemed to be "an expensive country to do business in", motivating the need for process innovations in particular to reduce costs. Changes in the valuation of Sterling, fluctuations in raw material prices, and the competitive nature of the industry were also cited as specific concerns by interviewees. Such factors were thought to both constrain innovation by reducing available resources, but also necessitate changes in order for SMEs to remain competitive. For example, the need to comply with demanding conditions of sale, as required by retailers, was perceived to be challenging:

> *The people with the biggest power are (…) where you are supplying into. When you are supplying into multiples, they have huge power. (Industry representative 1)*
>
> *If it is not going off the shelves relatively quickly, you can forget it. They [retailers] will cut it quite quickly. (Industry representative 1)*

Private label was also cited as a notable driver of innovations in a number of sectors:

> *We started 'branded', with the [removed to maintain confidentiality] brand. But the sector we were going into was driven by private label. So we are now doing about 80-90% private label. (Industry representative 2)*

The highlighted issues, in conjunction with evolving regulation, were cited as drivers of technological change in companies:

> *On the company side, there is pressure at all times from the technology side. It is changing technology, and changing specifications: new technical requirements for hygiene, food safety, regulations coming in, and maybe new processes. New problems. Maybe, new issues, I should say, more than problems nowadays, like low salt. Or old issues like quality which has [sic] to be revisited. All these things can be driving change. (Support agency representative 6)*

In relation to the Health Claims legislation, the cost implications represented a significant barrier for companies interested in pursuing this avenue of product differentiation:

> *I mean, with all these trials you have to do now. There will be nobody making claims because it is going to be so expensive. (Industry representative 2)*

However, it was felt to be an area with potential and a number of companies and agency-representatives expressed an interest in the opportunity presented by using a claim on a product:

> *Claims are a big thing at the moment. Every industry sector wants to be able to use claims. (Support agency representative 1)*
>
> *If we can develop another product and that other product then fulfils some of the criteria that they are talking about [Health Claim Legislation], then it could be quite useful for us. (Industry representative 1)*

The interest in this area opens up a prospective means of supporting the food industry in the future.

References to regulatory concerns were sector-specific at times, with dairy representatives discussing the removal of quotas; in contrast, the seafood representative was apprehensive about the introduction of more stringent quotas. The increase in supply of milk, which will result from the removal of milk quotas, was seen as an opportunity to add value and command high rates of return on innovative products. The tightening of fish quotas, alternatively, motivates process innovation towards lower costs, but also drives value-added product development in order to maintain profitability. Furthermore, issues driving reformulation of products specific to certain sectors (*e.g.* salt reduction in cereals, saturated fat reduction in dairy products) were also alluded to. These issues were not identified in the original questionnaire due to its structured format and the fact that it was tailored to be accessible to all sectors of the industry. From this, it is evident that using a qualitative approach to further build on quantitative findings can enhance the depth of information attained. As a result, the decision to follow a mixed methodological approach was justified.

Looking specifically at R&D tax incentives, a number of interviewees felt that they were not being utilised by the majority of companies. This reflects results from the survey in which tax incentives scored very poorly in terms of impact on innovative activities. In the interviews, this was attributed both to a lack of awareness of the availability of such incentives in some companies, and to the level of innovation culture in companies:

> *But in terms of tax incentives - I am not quite sure. I would imagine that they don't avail of all the tax incentives available to them (be)cause again we don't have the innovative culture in the companies. (Support agency representative 5)*

However, an industry representative from a company with a long-standing history of innovation indicated active involvement in, and awareness of, the EI R&D supports. Another industry representative from a company with increasing innovation efforts in recent years ("we've been doing a greater degree of research in the last few years") signified that while they were not currently availing of R&D tax incentives, it was probable that they would pursue this avenue of support in the future. These results suggest that a certain level of absorptive capacity is necessary to be able to realise the potential from such supports. Therefore, more targeted marketing of the availability of such supports to companies with developing absorptive capacity may increase the uptake.

8.8 Conclusion

This round of in-depth interviews was conducted in order to integrate and develop on the results already established in the initial stages of research. Firstly, the quantitative survey did not directly address the intersecting factors which underpin the relationships between industry and publicly-funded research agencies. A quantitative project investigating these factors had been conducted previously by DIT and Teagasc, the results of which are discussed in Henchion *et al.* (2008). However, in order to explore the model exhaustively it was decided to scrutinise these issues within the opportunity provided by the second round of interviews.

The absorptive capacity literature investigates the factors which influence a firm's ability to benefit from valuable external knowledge (Cohen and Levinthal, 1994). This round of interviews reinforces the way in which this body of literature provides a useful platform when attempting to better understand the relationship between Irish food companies and publicly-funded research providers. Interviewees contended that an evolved company absorptive capacity facilitated the transfer of knowledge between entities. It was asserted that, by developing this capacity, though infrastructure and human capital investment, a more advantageous relationship could develop (particularly if social capital is developed though graduate mobility between research institutes and industry).

The subjective nature of the interpretation of the term ‘innovation’ was another discussion point raised in the interviews. In line with definitions of Schumpeter (1950) and Porter (1980), industry was found to have an all-encompassing, pragmatic view of innovation. This definition was focused on the ‘value-adding’ possibilities from innovation, as described by Buxton (2005). This was opined to be in contrast to an esoteric, philosophised interpretation that arose from “brain-storming” sessions in the academic arena. The contrasting interpretations were felt to lead to information asymmetry between entities, often causing a “language barrier” which obstructed potential beneficial outputs. Again, absorptive capacity development in companies was promoted as an effective way of facilitating such associations. Furthermore, the potential for more targeted support of companies with differing levels of such capacity was also highlighted.

Further to this, the use of the term ‘new-to-market’ in the questionnaire to identify more radical innovations may not have sufficiently differentiated the truly radical innovations. This goes in some way to explain the high levels of reported ‘radical’ innovations in the sample of companies surveyed. A more appropriate measure going forward might involve a more sophisticated proxy of innovation level. Terminology used by interviewees that could be incorporated in this proxy include ‘involved research’ and ‘resulted in potential licensing of technology’. By improving identification of the level of innovation occurring in food companies, more targeted support can be provided by support agencies.

A number of anomalies arose during the analysis of the survey data relating to packaging innovators. When discussed in the interviews, respondents were of the opinion that MNC packaging suppliers were key players in influencing the decisions by food companies to engage in packaging innovation. Such companies were thought to provide a complete offering to food SMEs in Ireland which addressed their packaging needs, supported by the extensive development of packaging options by the MNCs themselves. In this way, SMEs were effectively outsourcing innovation to such MNCs. The mode by which packaging MNCs provide an offering that companies (often with low levels of absorptive capacity) can engage with, is an area worth further study. Examination of this interaction may reveal ways to provide similar offerings in the product and process arena. Concerns in relation to the perceived lack of impartial advice available were cited by interviewees. However, an area of controversy as to whether packaging should be on the publicly-funded research agenda in Ireland surfaced, with opinions divided on the subject.

In terms of priority placed on outcomes from investing in external knowledge, the measures applied in the survey were not found to be significantly different across increasing absorptive capacity levels. On investigating this issue further, it was found that formalised research targets were not thought to be widespread in food SMEs in Ireland. It is possible that food SMEs do not set specific research agendas for the future of the company and rely on a general sense of where they envisage the company going in the next few years.

Companies with low levels of absorptive capacity in this study were thought to be unaware of the need to change (*i.e.* ‘pre-contemplative’ as seen in Prochaska *et al.*, *1995*). This raises policy implications, as companies with low absorptive capacity may need specifically targeted interventions that animate the company before increasing absorptive capacity. This issue is important for future policy direction as both industries have significant potential to contribute to the Irish economy.

The potential bias arising from locating interviews in different regions of the country was not found to have a bearing on the factors impacting on company innovation. The improvement of the nation's infrastructure over the last decade was cited as a reason for this. However, a recent report has highlighted the issues with ICT infrastructure (such as poor access to, and quality of, broadband connection) and this should be addressed in this context.

Finally, the current relevance of the modified model was tested by asking interviewees about their perception of the environment that their business operated in. A number of sector-specific issues were unearthed at this stage that were not identified by the original quantitative cross-sector survey. This result validates the choice of a mixed methodology for this research. The extra richness which can be captured from the combination of the two methods is thus illustrated. Overall, no additional non-sector specific factors were established at this point. Therefore, the factors originally assessed were felt to be comprehensive in nature.

Chapter 9

Conclusion, recommendations and directions for future research

9.1 INTRODUCTION

The purpose of this research was to gain an understanding into the factors influencing food companies as they decide whether to invest in technologies emanating from publicly-funded research providers. Central to this investigation was the paradox that low levels of absorptive capacity both impede and necessitate the use of external knowledge in order to innovate. The exploration of this phenomenon, within the context of the Irish food industry, encompassed a review of the literature surrounding absorptive capacity, followed by a three-pronged, mixed-method, primary research approach. In this chapter, the main findings from this research are discussed, conclusions drawn and ultimately used as the basis for recommendations for industry and agencies working to support the industry. Finally, some opportunities for future research are outlined.

9.2 DISCUSSION AND CONCLUSIONS

A number of challenges face SMEs striving to innovate, including diseconomies of scale; lower levels of highly qualified human capital due to tight margins; lack of internal finances for innovation and lower levels of dedicated R&D resources, personnel and facilities (Traill and Grunert, 1997; Romijn and Albaladejo, 2002; Shefer and Frenkel, 2005; Supnithadnaporn and Jung, 2007; Fryer and Versteeg, 2008; Karantininis *et al*, 2010; Woerter and Roper, 2010). As a result of such challenges, the most likely sources of innovations, particularly radical innovations, are external to the company. This study reinforced previous work which suggested that it is the ability of the SME to identify and absorb relevant information from the external environment that is key to success. This ability was termed *absorptive capacity* by Cohen and Levinthal (1989, 1990, 1994) and has become a dominant theme in research (Zahra and George, 2002; Lane *et al.,* 2006; Todorova and Durisin, 2007, Fosfuri and Tribo, 2008; Fabrizio, 2009) and policy development (Forfás, 2005; NESTA, 2007; Department of Enterprise and Employment, 2008; SFI, 2009; Forfás, 2011) in the intervening twenty years. Therefore, the literature surrounding the concept of absorptive capacity was seen as an ideal frame to investigate the uptake of technological innovations by food SMEs.

The process of absorptive capacity was examined through the lens of a modified version of the Lane *et al*. (2006) model. This model was initially chosen because it was felt to give an excellent overview of the antecedents and outcomes of the process. Following extensive review of the literature and a series of in-depth interviews, with representatives from companies within the food industry and from agencies supporting the industry, a number of modifications were made to the model in order to ensure appropriateness to the study context. The original model variables were expanded to include issues of particular relevance to the Irish food industry, and two additional factors were added. Firstly, in the external factors, the potential impact of the economic environment was included, as availability of external finance facilitates innovation in tight margin industries such as the food industry. The inclusion of this factor was justified by how highly companies ranked the ‘state of the economy’ in the hierarchy of environmental factors influencing innovation in the subsequent survey. Secondly, motivated by input from the first round of in-depth interviews, a separate variable, ‘innovative culture’, was added to the factors internal to the company affecting absorptive capacity. In this study, a positive culture for innovation was found to relate to increasing preponderance of technological innovation and to increasing levels of absorptive capacity. In line with Traill and Grunert (1997) this was found to be particularly true for product innovators, with a culture of openness to change appearing to driving innovation in such companies. The importance of a positive innovation culture was also reinforced in both rounds of interviews. Therefore, it can be argued that a positive innovation culture is integral to the uptake of externally-sourced knowledge of relevance, particularly that pertaining to product innovations. As a result, improving the firm culture should be targeted as a potential means of improving engagement in innovation in SME food companies.

By investigating the factors external to the company influencing absorptive capacity, a hierarchy of drivers and barriers to innovation in Irish food companies could be established. The paramount importance of the customer as a driver of innovation was recognised by the majority of companies. Both the *Food Harvest 2020* vision for the food industry (Department of Agriculture, Fisheries and Foods, 2010) and the Forfás (2011) report on innovation in Ireland, stressed the importance of consumer-orientated offerings, backed by real market understanding. Although focusing on the current desires of customers can limit a company to incremental innovations, input from customers and market research data should form an integral part of future planning in all food companies.

The economic climate was the factor which was of next importance to the cohort, with both innovators and non-innovators concerned about the potential adverse effects on innovation efforts. Following this in rank were the power of retailers and the competitive nature of the industry. The strength of retailer influence was evident across all stages of the research. This finding is aligned with the observations of the *Food Harvest 2020* report, which cautions against the negative impact of the asymmetry of power between multiples and small companies. Alternatively, results from previous studies of retailer-manufacturer relationships in Ireland found that certain retailers were active in supporting innovation by providing a lower barrier to entry for emerging food SMEs (Collins, 2010). By the retailers acting as supply chain captains, they could direct innovation efforts to more effect across the whole chain. Improved relationships with retailers may increase the potential return for individual SMEs, and knowledge gained through serving the sophisticated UK retailer market places Irish food companies in a positive position in terms of capitalising on markets which are further afield (such as the Eurozone market) (Collins, 2010). Despite this, increased competition, particularly from international companies with a lower cost base, and greater economies of scale was also seen to be driving innovation in an effort to ensure company survival. Indeed, the challenging business environment, with factors such as increasing operational costs (*e.g.* energy and wages), was indicated as driving the need for Irish food companies to innovate. This was particularly in terms of incremental process innovations which facilitate a reduction in the cost base of a company.

The order by which industry ranked the importance of regulation requirements provided a revealing picture of the level of innovation ongoing in Irish food companies. The results of the survey point to a concentration of efforts on achieving the compulsory health and safety requirements and nutrition and allergen labelling regulations. Regulations that are associated with higher levels of innovation scored less well in terms of immediate importance (*e.g.* novel foods legislation). However, despite a pervasive wariness among industry representatives regarding the complexity and expense involved in the approval of health or nutrition claims, there was a tentative interest in this potential avenue of innovation. This is an area which could benefit from a focused system of support that can capitalise on the opportunities presented by the legislation. Such a service could also provide guidance on the means of exploiting the novel foods legislation. However, this was thought by interviewees to beyond the scope of the majority of Irish food SMEs. In terms of the knowledge environment, input from different agencies was appreciated for different levels and types of innovation. Input from An Bord Bia was perceived as useful, both in terms of incremental innovation, but also in terms of more radical innovations. Similar to findings by Romijn and Albaladejo (2002), the knowledge available from universities and research organisations was found to be particularity relevant to those engaging in innovations that were more radical.

The research also established that the type of technological innovation a company engages in has an influence on the way in which they rank the importance of environmental factors. While product innovators were more concerned about following consumer trends, process innovators appeared to be motivated by efforts to reduce operating costs (*e.g.* wages bill and energy costs). Interestingly, companies involved in packaging innovation did not appear to be motivated by the factors found to be driving process and product innovators. Although from a marketing perspective packaging changes may be considered part of product innovations, the technological considerations involved in product and packaging innovation are somewhat different. Given this fact, the factors which influenced packaging innovators were specifically investigated during the second round of interviews. During this investigation, the paramount importance of packaging suppliers came to the fore. Packaging suppliers appear to be providing a variety of well-researched packaging options to food companies in Ireland, complete with the knowledge and expertise to facilitate their absorption. These packaging offerings appear to be readily adopted by companies, often with low levels of absorptive capacity. In this way, food SMEs could be argued to be outsourcing the development of packaging to those specialising in the area. By investigating the intricacies involved in such transactions, insights could be gained that facilitate the provision of process and product innovations in a similar fashion, making this an interesting case-study for future work.

The investigation of the internal factors which contribute to absorptive capacity and the ability to innovate provided a better understanding of the current innovation capacity of Irish food companies, and highlighted areas of potential improvement. A number of positive findings were unearthed in the survey, including a high proportion of employees with post-school qualifications and a significant percentage of companies engaging in training that would facilitate innovation (new product development, innovation, marketing and sales, lean manufacturing). An emphasis on market research was also evident. This is a positive finding given the way in which focusing on the consumer was advocated by the *Food Harvest* vision (Department of Agriculture, Fisheries and Foods, 2010), Bord Bia report *Growing the success of Irish food and horticulture* (2009), and Forfás innovation report (2011). Continued support from Bord Bia and BIM in terms of providing this market data is essential for food companies. However, the key is not simply to carry out the research, but to also support companies in applying this information to their specific business needs. Also, there are further potential opportunities to expand on the current knowledge base by supporting companies to conduct their own market specific research.

The level of dedication of resources to NPD was reasonable high in the sample of companies surveyed. However, improvements in the type and level of facilities available to NPD may further benefit this area. Enhanced engagement with the EI R&D support structures and R&D tax incentives could also help improve NPD in Irish food companies. Tax incentive uptake has considerable potential for expansion, with efforts from both companies and support agencies required. The uptake of such incentives appeared to be facilitated by absorptive capacity improvement, and therefore interventions to enhance absorptive capacity may facilitate such a development. In terms of density of intra-company communication, there is potential to improve this, particularly given the apparent connection between communication linkage density and occurrence of technological innovation. Another area of potential improvement is in firm culture and openness to innovation. In the current study, a positive innovation culture was not found to be related to strategy for innovation, firm size, engagement in IP protection, market orientation or presence of an NPD function. However, it was integral to facilitating technological innovation. This suggests the predominance of 'hidden innovations' within the food industry, which are not identified by conventional measures. The importance of culture in driving innovation may have been overlooked until now in relation to Irish food SMEs and is an area of interest for further study. Although, controversy exists in the literature as to the benefit of direct senior management involvement in NPD, this study sided with the positive effect of such involvement on innovation occurrence.

The high level of post-graduate employees indicated to be present in this cohort is an area of particular interest, given the EGFSN (2009) report on future skills needs in the food industry. This report opined that the recent increase in the complexity of the food industry necessitated the involvement of greater numbers of highly qualified personal. Furthermore, improved social capital can be regarded as a benefit of the diffusion of trained graduates into the industry from the national research providers (*i.e.* the links back to the original organisations form a network to diffuse research outputs and also increase the absorptive capacity of the industry as a whole). In fact, when discussing the intersecting factors of the model with respondents in the second round of interviews, absorptive capacity was thought to be an important facilitator of the collaborations between industry and research providers. The significance of personal relationship between industry and researchers was also deemed integral in this respect, in accordance with the findings of the *Toolbox* project (O'Reilly and Henchion, 2010). Identifying and developing such connections with company gatekeepers would potentially facilitate this process. Building on this logic, the concept of a dedicated gate-keeper, as an interface between the company and the research institutes, is given credence. Thus, a dedicated gate-keeper may have considerable potential as a means of increasing effective collaborations with industry. However, if such an avenue of support was pursued, it is probable that the absorptive capacity of the company would be limited by the capacity of the selected 'gate-keeper'. Therefore, the selection and training of this individual would need careful consideration.

When clustering companies according to their absorptive capacity level, two measures were used in the current study. When comparing the two measures [receptivity to external sources of innovation (M1), and the perceived value placed on such sources (M2)] the first measure generally identified clearer differences between groups than the second. As the second measure was limited to innovators, the subtle differences in distinguishing characteristics between each level of absorptive capacity may have been more difficult to discern. The first measure of receptivity to external sources identified three groups of companies with increasing levels of absorptive capacity. The higher groups were more likely to have engaged in technological innovation and also had higher levels of the supportive factors which contribute to innovation [*e.g.* high levels of post-school qualification in employees, positive culture for innovation, and higher level of NPD (as indicated by the R&D proxy)]. On a separate note, companies with lower levels of absorptive capacity appeared to perceive less of an impact from the business environment. Such companies did not seem to recognise the relevance to their activities of the drivers of innovation that were motivating companies with higher levels of absorptive capacity. As a result they were unaware of the need to change in order to adapt to the dynamic business environment facing Irish food SMEs. If such companies do not appreciate the environmental pressures necessitating innovation, they may be reluctant to engage in interventions to improve their level of absorptive capacity. This finding must be taken into account when developing interventions: as such companies may need to be animated initially. For example, when applying the Prochaska *et al.* (1995) *stages of change model* to this situation, such companies would be termed *pre-contemplative* in nature (*i.e.* unaware of the need to change). Targeted interventions for this stage of change (as per Prochaska's model) involve the provision of information regarding the problems at hand and the reasons for change (Prochaska *et al.*, 1995). By providing this information it is hoped that the company would recognise the applicability of these issues to their current position and move into the *contemplative* stage (where the company appreciates the need to change and considers changing). By internally realising the need to change, the locus of control and drive to change stems from within the company, as opposed to being externally enforced. When this stage is reached, support can be externally provided so as to facilitate the change required. This support is taken up more readily than if no desire to change existed in the company. Such targeted interventions may be a more effective method of using the sparse available resources than providing the same type of support to companies at different stages of change.

From the survey and semi-structured interviews, gaps in knowledge relating to each stage of the absorptive capacity process were identified. Some companies required support to access and translate the available information into usable data. Others had accessed ideas and needed support in terms of the practicalities of integrating these ideas into their current activities. Finally, another set of companies emerged that required aid in commercialisation and scale-up of the innovation. The support-agencies and research providers appeared to have a role in supporting different stages of this process. Therefore, results from the study suggested that identifying companies with different levels of absorptive capacity, and targeting interventions accordingly, may also be an effective way of providing assistance to Irish food companies.

Another issue highlighted was the importance of considering the type of language used when interacting between such entities. Harmonising the language used in dissemination activities and using the terminology commonly used by companies, may contribute to increased success of collaborative efforts. Again, the prospect of targeting companies at differing levels of absorptive capacity comes to the fore in this respect.

The measures employed to assess the outcomes of the technological innovation component of the model did not reach significance when tested against increasing levels of absorptive capacity or engagement in innovation. The problem may lie in the lack of tangible data relating to the outcomes provided by the survey, due to its voluntary nature. Further investigation, in the second round of interviews, revealed that small companies were not thought to have formalised innovation outcome measures in place, and this may have influenced this result. However, the factors used may have relevance to larger companies and to other industries. Therefore, this section should not be excluded from the model without further research.

Finally, the measurement of innovation in SMEs has received increasing attention over recent years (Rominj and Alberderjo, 2002; Freel, 2004; Batternick *et al.* 2009). This is also true for industries that have traditionally scored poorly in terms of innovation levels when assessed using conventional measures (*e.g.* patent counts and R&D spend) (NESTA, 2007; Forfás, 2011). The concept of ‘hidden’ innovation

(NESTA, 2007) has emerged as a means of accounting for the forms of innovation that are not identified by such measures. This industry has been previously portrayed as a one with low levels of innovation (Lagnevik, 2003; Menrad, 2004). However, within the current study, and also several others investigating the types and levels of innovation in the industry (Garcia Martinez and Benz, 2000; Avermate *et al.*, 2006; Forfás, 2011), a different picture emerged. The level or 'radicalness' of the innovation occurring was not necessarily 'new-to-world'. However, these forms of innovation may not be best suited to the food industry, which is thought to be a 'carrier' industry (implementing innovations created in other industries). Furthermore, the industry is constrained by limitations in the openness of consumers to radical food-related concepts and by tight margins. Instead, innovation in the industry centres on capitalising on market information, work practice innovation and expansion into new markets. Dedicated resources for high level research and development and rigid innovation strategies may be lacking in the majority of companies, further contributing to the low perceived levels of innovation, but again the relevance of such factors to this industry were called into question. Conversely, the importance of a culture for innovation and an openness to change was evident in this study. In addition, developed communication linkages, active market research and managerial interest and involvement in driving NPD were significant. Therefore, a sector-specific index of innovation, including aspects of hidden innovation, may be of particular relevance to the food industry. NESTA (2007) have undertaken a considerable amount of work in this area. Initially it focused on a selection of sectors traditionally portrayed as low innovators (*i.e.* oil production, retail banking, construction, legal aid services, education and the rehabilitation of offender), which led to the development of sector specific indexes in the following sectors: accountancy services, architectural services, automotive, construction, consultancy services, energy, production, legal services, software and IT services, specialist design (NESTA, 2009). Although, an index specific to the food industry has not been developed as yet, lessons learned over the course of the investigation provide valuable insights into the process of developing an index. By building on studies which were specific to the industry, such as Garcia Martinez and Benz (2000), Avermate *et al.* (2006) and the current study, in conjunction with more general surveys of innovation in Ireland (Forfás, 2011), such as index could be developed reasonably quickly.

9.3 RECOMMENDATIONS FOR FUTURE WORK

The recommendations arising from this research can be grouped into those for industry and for agencies supporting the industry.

9.3.1 Recommendations for industry

The most important area that needs to be addressed in companies is the further development of individual company absorptive capacity. This research has shown than improved absorptive capacity leads to higher levels of innovation. For example, improving the density of communication linkages will facilitate idea sharing in companies, and developing cross-functional teams can maximise the sharing of experience and knowledge, and in doing so, assist all forms of innovation. The entire process of innovation may be optimally supported through efforts to improve the culture inherent to the company and increased openness to innovation across the firm. Although, the development of the companies through investing in highly trained graduates is commendable, this advice must be considered within the realities of the low margin food industry. However, the flexibility inherent to SMEs provides an opportunity to optimise absorptive capacity through lower cost alternatives which capitalise on available resources (*e.g.* multi-tasking).

A practical way of rapidly maximising interaction with the knowledge environment may be to develop a gate-keeper of knowledge within the firm, who is responsible for developing relationships with research providers and support-agencies and acquainting themselves with market trends. From the examples provided over the course of this study, this may be best suited to a senior manager who has direct involvement in NPD. A dedicated gate-keeper, in combination with the improvement in the broad company culture, would be most favourable.

By developing the absorptive capacity of the firm, availing of currently accessible supports, such as R&D tax incentives and grants, could be increased in the near future. This is currently an area of weakness which could be significantly and speedily improved from a company perspective. Another area which should be addressed presently is the allocation of training resources. When optimal levels of health and safety standards are achieved in companies, there may be an opportunity to designate training expenditure to more innovative focussed training, such as improving market awareness and market research competencies. The more extensive provision of such targeted courses is an area of potential opportunity for support-agencies.

Although difficult within the economic current climate, a longer term view of the company direction is also recommended, as the development of such supportive internal factors would be better facilitated. By supporting innovation in this way, companies should become better equipped to deal with the evolution of consumer trends, mounting operating costs, intense competition and demanding conditions of supply from retailers. If such improvements were put in place, exporting to markets not affected by adverse currency movements will also be facilitated, providing extensive opportunities for growth.

Another longer-term option for companies that emerged was the outsourcing of innovations such as appears to occur with packaging innovation. The ability to provide a complete bundle of either product or process innovations will need to be developed by research providers or relevant industry sectors initially. However, opportunities to engage in this type of innovation may be forthcoming in the coming years. If so, it is important that the company has sufficient absorptive capacity to recognise the value, integrate and commercialise this. Therefore, in conclusion, the development of company absorptive capacity is the first step in facilitating availing of potential opportunities in the future and thus needs to be prioritised.

9.3.2 Recommendations for support-agencies and government organisations

The most immediate recommendation that arises from this research is the need to ensure that measures of innovation account for the innovation that is of importance in each specific industry. Traditional measures of innovation, including R&D expenditure and patent counts, have branded the food industry as a low level innovator. However, measuring the actual occurrence of innovation tells a different story. Innovations in the food industry may not be 'new-to-world' concepts, but these may not be best suited to the low margin, consumer imagination-constrained industry. Industry specific measures that account for 'hidden' innovation may be a more important consideration when differentiating between companies in the industry. Such measures could dovetail on the work of NESTA, which investigated hidden innovation in other industries, but also build on the work of food industry specific surveys such as Avermaete *et al*. (2004), Garcia-Martinez and Benz (2000) and the current study. Examples of measures of importance that arose from the current study and others include the following: a culture for innovation; engaging in market research; involving support-agencies in innovation activities; collaborating with research institutes; return on products not produced by the company five years ago; accessing new disparate markets; implementing lean manufacturing principles; collaborating with other companies to address the needs of a large customer; and engaging in new forms of distribution. By gauging the occurrence of such ‘innovations’, viable companies can be identified and supported by interventions described below. This work needs to be prioritised over the coming months, as an accurate picture of the current situation would best facilitate successful interventions to improve the level of innovation in the industry. A collaborative effort by the Department of Agriculture, Fisheries and Food and the Department of Jobs, Enterprise and Employment is advisable, drawing on the industry specific knowledge inherent to Teagasc, Bord Bia and Enterprise Ireland. Due to the level of experience in innovation surveying, Forfás may be best placed to coordinate this piece of research.

The second recommendation must follow the implementation of the previous recommendation, and relates to the potential opportunity that arises from identifying companies of different levels of absorptive capacity and tailoring interventions accordingly. A simple method of gauging this level was provided in the thesis: the receptivity to external sources of innovations was used as the basis of differentiating between such companies. By targeting interventions in this way, resources can be used more effectively. Purposeful assistance for the stages along the process of absorptive capacity may be of particular benefit. Specific to the practicalities of such interventions, appropriate language usage and the importance of compatibility with product portfolios cannot be understated. Furthermore, identifying and targeting an appropriate gate-keeper in companies would facilitate this process.

In the meantime, a number of environmental factors are impacting adversely on Irish food SMEs and need to be addressed at government level. Consolidation of retailers has caused a power imbalance between suppliers and the larger multiples. Although opportunities to avail of support from retailers to innovate exist within the current system, strict monitoring of the activities of all the players involved is needed to ensure responsible practices are adhered to. Furthermore, a review of the regulation requirements faced by food SMEs that ensures all of the requirements are in the best interest of all actors would also be beneficial.

Another area which could be addressed directly relates to PhD and masters programmes in Ireland. The diffusion of graduates into the food industry from TLIs and research organisations can develop the absorptive capacity of the industry through social capital and improved level of human capital. The contribution of FIRM to this process is recognised. However, it is important to ensure that those graduating are well-rounded and versed in the requirements of industry. The Food Graduate Development Programme (FGDP, 2009) goes some way to addressing this need, however, a practical work experience element to PhDs and masters courses would improve on this further. Schemes such as the Irish Research Council for Science, Engineering & Technology (IRCSET, 2011) academic-industry partnership could be used as a basis for widespread incorporation of work experience in to post-graduate programmes. This scheme offers researchers the opportunity to gain additional beneficial experience and insight into the commercial arena while completing their research.

In the longer term, while the support provided to help companies achieve health and safety requirements appears to be at a high level, there is an opportunity to engage with companies interested in achieving health or nutrition claim status. A large-scale example of a collaborative effort between research organisations, support agencies and the dairy industry is provided by the Food for Health Initiative Ireland (Henchion and Sorenson, 2011), which is aimed at developing, manufacturing, marketing and selling nutritional ingredients and functional food products. On a smaller scale, in other sectors of the industry, similar collaborations could prove beneficial. Interested companies working with support agencies could stimulate idea generation and support commercialisation, with the research providers supplying the expertise and potential products/ingredients. In fact, the technical expertise available in TLIs may be a useful means of filling the gap relating to low levels of engineering input into NPD in SMEs. The low level of such expertise in SMEs was an issue highlighted throughout the primary research. Furthermore, there is significant potential for Irish food companies to engage in licensing-in technology from other countries. Although Irish food SMEs typically eschew such formal mechanisms, supporting companies with increased absorptive capacity may create another success, such as Cheesestrings™[30], in the future.

9.4 THEORETICAL CONTRIBUTIONS

This research has made a number of important theoretical contributions. Firstly, the in-depth investigation of innovation in Irish food SMEs carried out over this study enabled the development of a deeper understanding of this issue. Gaps pertaining to this area were noted over the course of the examination of the literature. Previous studies have been undertaken in other European countries such as Belgium (Avermaete *et al.*,2003), Spain (Garcia Martinez and Benz, 2000) and France (Le Bars *et al.*,1999). However, investigations within the Irish context have been limited. Innovation surveys have been undertaken at a national, cross-industry level (*e.g.* CIS), however, the detail provided by this study can only explore this complex area further.

[30]The process of making of making mozzarella cheese was patented by Leprino Foods in the US in 1993 (US Patent 5567464). Kerry Group, Ireland attained a licence for the process and began producing Cheestrings for the European market. By 2009 sales had reached €80 million a year (Ryan, 2009).

This study also took place in a time of unprecedented challenges for the Irish economy. The study spanned the deepening of a worldwide recession, the recapitalisation of the Irish banking system and the involvement of the European Central Bank and International Monetary Fund in the financing of the country. As a result, it provides insights into the means by which these rapidly changing circumstances affected the Irish food industry. Furthermore, the study enabled the establishment of a hierarchy of drivers and barriers to innovation in Irish food companies.

In terms of the absorptive capacity literature, this study makes a valuable contribution to an area which has been traditionally lacking in studies specific to small companies and to the lower technology industries, such as the food industry. The application of the Lane *et al.* (2006) model to the current context provides a useful frame through which the factors influencing absorptive capacity can be examined in future studies. The addition of the culture construct further develops this model, specific to this context and may also have relevance to other industries, particularly low-tech industries with high levels of SMEs. Again, the application of the absorptive capacity literature to the Irish food industry is an extension of previous studies conducted in this area (Henchion *et al., In press* A, B; Henchion et al., 2008; Kelly *et al.,* 2008) as it focuses on the perspective of the company as opposed to the research provider. This approach to investigating this issue is also in line with suggestions by Menrad (2004) and Triall and Grunert (1997) in which the low level of absorptive capacity in small food firms is discussed. The empirical evidence in this study, which links a developed absorptive capacity with the increased occurrence of innovation, is also an important contribution to this field.

As discussed, industry specific measures that account for ‘hidden’ innovation are an important consideration when differentiating between companies in low-tech, food SMEs. The creation of this measure within the food industry will be facilitated by the findings of innovation food industry specific surveys such as Avermaete *et al*. (2004), Garcia-Martinez and Benz (2000) and the current study.

9.5 FUTURE WORK

A number of opportunities for potential future work arise from this research. Firstly, the investigation of case-studies of the uptake of packaging innovation by Irish food companies could be of particular interest. By investigating the intricacies involved in such transactions, insights could be gained that facilitate the provision of process and product innovations in a similar fashion. Secondly, the stratification of companies by innovation type or absorptive capacity level, and the targeting of interventions accordingly, could improve the efficacy and effectiveness of the currently available supports. Pre- and post-intervention assessments, which could identify changes in attitudes and behaviours arising from the interventions, would facilitate the development of evidence-based practice for the future.

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Appendix I
Novel Foods

Novel

The Collins Dictionary defines the adjective *novel* as “fresh, new or original” (McKeown, 2008). The terms ‘emerging’, ‘latest developments’ and ‘most recent advances’ are used interchangeably in literature referring to ‘novel’ food technologies (Sun, 2005).

Novel foods

Novel foods are defined by the Dictionary of Food Science and Technology (International Food Information Service, 2005) as “foods prepared using unconventional processes (particularly genetic technology), derived from unconventional sources of offering non nutritional benefits (*e.g.* biotechnologically derived foods, designer foods and medical foods)”.

In Europe, the definition of novel foods is governed by the Novel Food Regulation, EC (No.) 258/97. Under this legislation, foods which have no history of significant[31] consumption in the European Union prior to 15 May 1997 are deemed ‘novel’. To market a ‘novel’ food within the EU, it must be proven safe. To do this, a company makes an application to the food safety authority of one of the member states (which contains a scientifically supported safety assessment or evidence of significant consumption in an EU member state prior to the deadline in 1997). Once the member state issues an initial safety statement, it is forwarded to the other member states, which have 60 days to input. Any objections are passed to the European Food Safety Authority (a designated panel of specialists who assess the validity of the evidence) (Hermann, 2009). The categories included under this regulation are detailed in Table AII.1. A sample of the foods that were applied for under this regulation is presented in Table AII.2. A simplified application can also be made for a product that demonstrates ‘substantial equivalence’ to a novel food already deemed safe (the required timeline for processing is significantly shorter for such applications).

[31] The term “significant” consumption is not specified and is subject to interpretation (Hermann, 2009)

Table AII.1 Novel foods/ingredients included under Regulation (EC) No 258/97

Foods and food ingredients which present a primary molecular structure
Foods and food ingredients which consists of micro-organisms, fungi or algae
Foods and food ingredients which consist of or are isolated from plants or isolated from animals
Foods and food ingredients whose nutritional value, metabolism or level of undesirable substances has been significantly changed by the production process

Source: Adapted from European Commissions (1997)

Table AII.2 Sample of Novel Foods applied for under the Novel Food Legislation

Commission Decision: *Accepted*	
2011/80/EU	Sardine Peptide Product
2011/76/EU	Chitin-Glucan
2009/778/EC	DHA-rich algal oil from *Schizochytrium sp*.
2009/752/EC	Lipid extract from *Euphausia superba*
2010/228/EU	*Morinda citrifolia* L. Fruit puree and concentrate
2009/355/EC	Lycopene Oleoresin from tomatoes – extension for food use
2009/826/EC	Two leaf extracts from lucerne
2009/827/EC	Whole Chia (*Salvia hispanica* L.) and Ground whole Chia
2008/985/EC	Leaves of Morinda citrifolia
2008/968/EC	Arachidonic acid-rich oil from Mortierella alpina
2008/575/EC	Baobab dried fruit pulp
2008/559/EC	Allanblackia seed oil
2008/558/EC	Refined echium oil
2008/413/EC	Alpha-cyclodextrin
2008/36/EC	Phytosterols/phytostanols
2006/68/EC	Genetically modified maize line MON 863
2006/69/EC	Genetically modified Roundup Ready maize line GA21
2005/581/EC	Isomaltulose
2005/448/EC	Genetically modified maize line NK 603
2004/657/EC	Sweet corn from genetically modified maize line Bt11
2003/867/EC	Salatrim
2003/426/EC	Noni juice
2001/424/EC	Fruit-based preparations produced using high-pressure pasteurisation
2001/721/EC	Trehalose
Commission Decision: *Refused*	
2005/580/EC	Betaine
2001/17/EC	Nangai nuts
2000/196/EC	Stevia rebaudiana Bertoni

Source: Adapted from European Commission (2009)

Outside Europe, a number of differences exist in regulations pertaining to novel foods. In contrast to the time related criterion provided in the European regulations (*i.e.* any product not significantly marketed in the EU before 15th May 1997), the Canadian regulation refers only to products not used as food before. Therefore, a product consumed in a country outside Canada would not have to pass a safety assessment. Secondly, the Canadian regulation makes specific reference to foods that have undergone genetic modification (GM). In Europe, before 2003, a number of products derived from genetically modified organisms (GMOs) were passed under the 'substantially equivalent' clause of 258/97. However, GMOs are now regulated under EC (No.) 1829/2003 (and are subject to traceability and labelling requirements as a result). In Australia and New Zealand, foods that are 'non-traditional' (*i.e.* no history of consumption in Australia or New Zealand) must be listed on the *Standard 1.5.1 - Novel Foods* before permitted for sale. An application must be made to the Food Standards Australia New Zealand (FSANZ) to amend this list in favour of any food classified as 'non-traditional'. Similar to the European Legislation, any substance, which does not have a history of consumption within the specific region is subject to the validation process. In addition, there is also a separate regulation for GM foods (Standard 1.5.2 – Food produced using Gene Technology), in which mandatory pre-market approval and labelling requirements are enforced (FSANZ, 2010).

Appendix II

Interview guide for first round of semi-structured interviews (industry)

Introduction

- Thanks
- Introductions
- Aim

This project is examining the factors that influence taking on novel food technologies by Irish food companies. It is part of a larger FIRM funded project which also looks at consumer acceptance of these technologies.

- Choice of interviewee
- Duration 45 mins – 1 hour
- Confidentiality
- Back out at any time or not answer questions
- Recorder/notes
- Any questions before we proceed

A. General opening and company orientation Qu.: I just want to check the activities your company are involved in. You are well known for producing X, could you tell me a bit more about your current product portfolio? *Prompts: newest product line, when was this launched, how would you rate its novelty?*
B. General/Business environment Qu: What are the main factors is the business environment that affects your company? *Prompt: factors beyond the company's control, looking beyond the recession what other factors do you see as challenging Irish food companies? Biggest challenge? What strategies at a national or company level are in place to overcome these?* *Biggest market opportunity for food companies presently? Challenges to realizing the value of these marketing opportunities? How do you go about conducting or availing of market research? How open do you think consumers are to new food products?*
C. Industry Environment Qu: How do you think the structure of the food industry influence innovation? *Prompt: has this changed in recent years?* *(as raised: different sectors main players, exports, competition, down stream pressure)* **D. Regulatory environment** Qu: Is regulation a factor for the food industry? How so? *Prompt: Influence on innovation, affects on this company? EC regulation, Novel foods law, health claims law,*
E. Networks Qu: Do you think support networks or bodies have much of a role to play in the Irish food industry? *Prompt: can you tell me about this company's networks? Involvement with industry bodies? Statutory bodies? What do you think of the opportunities for participation in open innovation/ networking opportunities in Ireland?*
F. Knowledge environment Qu: How active do you think companies are regarding research and development is in the? How active do you think research institutes and universities are in food research? *Prompts: R&D department, awareness of projects ongoing in public bodies? Have you collaborated with government organisations or universities before? Would you again?* *What government supports are in place to help your research plans? Are there any financial support programmes available? How appropriate are they for your company? Difficulties?*

G. Links between external and internal environment Qu: What are the issues which arise when translating research from organisations such as Teagasc, UCC or UCD into something useful for the food industry? *Prompt: easy process? Any problems arising?*
H. Definition of innovation Qu: What is the most innovative aspect of this company’s products? What does innovation mean to you? *Prompt: Looking beyond this company’s product portfolio can you give an example of food process or product that embodies innovation? What aspects are particularly innovative?* What would you say is the most important factor in NPD? Does NPD always involve R&D?
I. Technology as a source of innovation Qu: What would you say the key technology used in this company is? What do you think about technology as a source of innovation? *Prompt: Are there any technologies you have heard of that you think has potential for the food industry?* Do you have a formal process for evaluating technology? Have you recently evaluated any technology for suitability within this company? *Prompt: how did this come to you attention? Will you proceed with this technology? Why so?* Qu: Based o your experience with taking on technologies, what kind of benefits would are you looking for in novel technologies? *Prompt: What influence would the ease of use of this technology have?* *If you could try out the technology on a pilot scale first, how would this influence your decision to take it on?* Qu: Is technological innovation a priority for this company currently? How is this reflected practically in the company? *Prompt:(as raised: firm ethos, support for innovation ideas)*
J. Size of company and internal issues and policies for innovation Qu: How do you think the size of this company influences taking on a novel technology? Qu: Are their any factors, **internal** to this firm which facilitate innovation occurring? *Prompt: What are the issues within a food company which might hinder taking on a novel technology?* *Do you have any strategies in place to facilitate innovation within the company?* *How open is this company to taking on new innovations?*
K. Decision making structure Qu: I understand this company to be quite centralised/decentralised? How does this impact on taking on a novel technology? *Prompt: easier/harder to get decisions made*
L. Management policies Qu: Who, on a managerial level, would be most involved when taking on novel technologies? What are their job title and their role?
M. Human capital Qu: How do you think food industry employees, in general, handle taking on a novel technology? *Prompt: reluctant to change, open to change, skill level, training,* *(You mentioned earlier) the R&D department, any dedicated R&D personnel? What are the highest qualifications of these staff? Are they located in Ireland or abroad?*
N. Intellectual property Qu: How active are Irish companies in the area of protecting intellectual property rights? *Prompt: What issues do you think arise for Irish SMEs in protecting their intellectual property? What is the level of awareness of these protection mechanisms in your experience? What forms of IP does this company have at the moment? Patents/tm/design r.*
Close: *Summary and paraphrase, reflect answers* Finally, are there any other factors you think influences Irish food companies taking on novel technologies that I have omitted?

Appendix III

Interview guide for first round of semi-structured interviews (non-industry)

Introduction
- Thanks
- Introductions
- Aim

This project is examining the factors that influence taking on novel food technologies by Irish food companies. It is part of a larger FIRM funded project which also looks at consumer acceptance of these technologies.
- Choice of interviewee
- Duration 45 mins – 1 hour
- Confidentiality
- Back out at any time or not answer questions
- Recorder/notes
- Any questions before we proceed

K. General opening and company orientation Qu.: To start can you give me an idea of the projects you are working on currently? *Prompts: how does your organisation supports the food industry, how many employees are dedicated to supporting the food industry? What does that involve?*
L. General/Business environment Qu: What are the main factors is the business environment that affects Irish food companies? *Prompt: factors beyond a company's control, looking beyond the recession what other factors do you see as challenging Irish food companies? Biggest challenge? What strategies at a national or company level are in place to overcome these?* *Biggest market opportunity for food companies presently? Challenges to realizing the value of these marketing opportunities?* *How important do you think market research is for Irish food companies? How open do you think consumers are to new food products?*
M. Industry Environment Qu: How do you think the structure of the food industry influence innovation? *Prompt: has this changed in recent years?* *(as raised: different sectors, main players, exports, competition, down stream pressure)* **N. Regulatory environment** Qu: Is regulation a factor for the food industry? How so? *Prompt: Influence on innovation? EC regulation, Novel foods law, health claims law,*
O. Networks Qu: Do you think support networks or bodies have much of a role to play in the Irish food industry? *Prompt: What do you think of opportunities for participation in open innovation/ networking opportunities in Ireland? To what level are Irish FCs involved with industry bodies? What about the role of statutory bodies?*
P. Knowledge environment Qu: How active do you think companies are regarding research and development? How active do you think research institutes and universities are in food research? *Prompts: how many Irish FC would have an R&D department, do many collaborated with government organisations or universities? Is there an awareness of projects ongoing in public bodies? Have you heard of any projects you think will benefit the food industry?* *What government supports are in place to help research plans? What financial support programmes are available? What issues arise when collaborating with companies?*
Q. Links between external and internal environment Qu: What are the issues which arise when translating research from organisations such as

Teagasc, UCC or UCD into something useful for the food industry? *Prompt: easy process? Any problems arising?*
R. Definition of innovation Qu: What role does innovation have in the food industry? What does innovation, the word, mean to you? *Prompt: Can you give an example of food process or product that embodies innovation? What aspects are particularly innovative?* What would you say is the most important factor in NPD? Does NPD always involve R&D?
S. Technology as a source of innovation Qu: What do you think about technology as a source of innovation? *Prompt: Are there any technologies you have heard of that you think has potential for the food industry?* Have you ever been involved in evaluating or promoting a technology for use in the food industry? *Prompt Can you tell me more about this technology? How did it go?* *In your experience, do Irish FCs have a formal process for evaluating technology?* *How do they hear about novel technologies?* Qu: Based on your experience with taking on technologies, what kind of benefits are food companies looking for in novel technologies? *Prompt: What influence would the ease of use of this technology have?* *If a technology was available on a pilot scale first, would this influence your decision?* Qu: Is technological innovation a priority for Irish food companies currently? How is this reflected practically in the company? *Prompt (as raised: firm ethos, support for innovation ideas)*
T. Size of company and internal issues and policies for innovation Qu: How do you think the size of companies' influences taking on a novel technology? Qu: Are their any factors, internal to a firm which facilitate innovation occurring? *Prompt: What are the issues within a food company which might hinder taking on a novel technology?* *Have you come across any firms with strategies in place to facilitate innovation? What did the strategies involve?* *How open are Irish food companies to taking on new innovations?*
K. Decision making structure Qu: Looking at the decision making structure of food companies, how does this impact on taking on a novel technology? *Prompt: easier/harder to get decisions made*
L. Management policies Qu: Who, on a managerial level, would be most involved when taking on novel technologies? What is their job title and their role?
M. Human capital Qu: How do you think food industry employees, in general, handle taking on a technology? *Prompt: reluctant to change, open to change, skill level, training,* *Have you worked with R&D department? What, in your experience, are the highest qualifications of these staff? Are they located in Ireland or abroad?*
O. Intellectual property Qu: How active are Irish companies in the area of protecting intellectual property rights? *Prompt: What issues do you think arise for Irish SMEs in protecting their intellectual property? What is the level of awareness of these protection mechanisms in your experience? What forms of IP have you come across being used? Patents/tm/design r.*
<u>Close:</u> *Summary and paraphrase, reflect answers* Finally, are there any other factors you think influences Irish food companies taking on novel technologies that I have omitted?

<u>Wrap Up</u> Thank you for your time. We hope to use the information gathered in these interviews to complete a larger postal survey of the topic. Please feel free to contact me at any time.

<u>Contact Summary Sheet</u>

Name:
Organisation:
Contact Details:
Location:
Date:
Time:

1) What were the main themes that stuck with you in this contact?

2) Summarise the information you got on each of the target questions
   a. Innovation

   b. Internal

   c. External

   d. Technology

3) Other points of interest during interview

4) Learning points to bring forward to next interview

Notes:

Appendix V

Research Questionnaire- National Survey of Company Innovation Activities

Research Questionnaire

National Survey of Company Innovation Activities

Please return your completed questionnaire in the
FREEPOST envelope provided

Thank you for taking the time to complete this questionnaire. In appreciation of your time, we would be delighted to offer you a summary of the key findings of our study.

Q. 1 In the last three years did your company introduce a *(please tick all that apply)*:

	Y	N		Y	N
New or significantly improved **product**?	☐	☐	If yes, was this product:		
			new to the *company*	☐	☐
			new to *market*	☐	☐
New or significantly improved **process**?	☐	☐	If yes, was this process:		
			new to the *company*	☐	☐
			new to *market*	☐	☐
New or significantly improved **packaging**?	☐	☐	If yes, was this packaging:		
			new to the *company*	☐	☐
			new to *market*	☐	☐
New or significantly improved **marketing approach?**				☐	☐
New or significantly improved **distribution approach?**				☐	☐
New or significantly improved **raw material supply**?				☐	☐
New or significantly improved **organisational structure?**				☐	☐
New or significantly improved **work practice?**				☐	☐

For the purpose of this study we define innovation to include any of the options listed in Question 1 (Q 1). If you have answered 'N' (No) to all the above options please skip to question 5 (Q 5)

Q. 2 Which of the following ***regulation*** requirements impact on your company's ***innovation activities*** *(Please tick all that apply):*

	Y	N		Y	N
HACCP	☐	☐	Bord Bia Quality Assurance Schemes	☐	☐
Nutritional information labelling	☐	☐	Labelling requirements for allergens	☐	☐
Novel Foods Legislation	☐	☐	Nutrition and Health Claims Legislation	☐	☐
International Organisation for Standardization (ISO) requirements	☐	☐	British Retail Consortium (BRC) requirements	☐	☐
Other *(please specify):*					

Q. 3 In what way has the Nutrition and Health Claims Legislation 1924/2006/EC affected your company's innovation activities? *(Please tick all that apply).*

	Y	N		Y	N
Adapted labels	☐	☐	Modified advertising	☐	☐
Adopted new processes	☐	☐	Decreased commitment to R&D	☐	☐
Modified existing processes	☐	☐	Increased commitment to R&D	☐	☐
Reformulated products	☐	☐	Increased need for external consultation	☐	☐
Increased staff training costs	☐	☐			
Other *(please specify):*					

Q.4 Please indicate, over the **past three years** (a) the extent to which each of the following factors have had an impact on **your** company's ***innovation*** activities and (b) what type of effect it had on ***innovation*** in **your** company *(please circle on the appropriate scales):*

	(a) Extent of impact on innovation activities						**(b)Type of impact on innovation**		
	None	*Some*			*A lot*		*Constrains innovation*	*Has no effect on innovation*	*Encourages innovation*
Retailers	1	2	3	4	5		1	2	3
Consumer trends	1	2	3	4	5		1	2	3
Suppliers	1	2	3	4	5		1	2	3
Competitors	1	2	3	4	5		1	2	3
Energy costs	1	2	3	4	5		1	2	3
Wages bill	1	2	3	4	5		1	2	3
Raw materials	1	2	3	4	5		1	2	3
Waste charges	1	2	3	4	5		1	2	3
State of economy	1	2	3	4	5		1	2	3
Exchange rates	1	2	3	4	5		1	2	3
Availability of credit	1	2	3	4	5		1	2	3
Tax incentives	1	2	3	4	5		1	2	3
State Grants	1	2	3	4	5		1	2	3

Q. 5a Does your company conduct market research? Y ☐ N ☐

If yes, is the market research: Conducted in-house Y☐ N☐ Contracted out: Y☐ N ☐

Q. 5b What has been the outcome of the market research in the **last three years** *(Please tick all):*

	Y	N		Y	N		Y	N
No outcome	☐	☐	Adopted new process	☐	☐	Entered new markets in		
Altered existing products	☐	☐	New product developed	☐	☐	-new countries	☐	☐
Altered existing process	☐	☐	Modified packaging	☐	☐	-new segments in	☐	☐
New packaging solutions	☐	☐	Accessed new customers	☐	☐	existing markets		

Q. 6 Does your company have any formal strategies in place e.g. Innovation strategy, lean manufacturing strategy?

If yes, please detail ____

____

Q.7a Which of the following types of ***staff training*** did your company fund (fully or in conjunction with a food support agency) **in the last three years**? *(Please tick all that apply)*

	Y	N		Y	N		Y	N
Food regulation	☐	☐	Sales & Marketing	☐	☐	New product development	☐	☐
Lean principles	☐	☐	Innovation	☐	☐	Change management	☐	☐
Team work	☐	☐	Leadership	☐	☐	Supply chain management	☐	☐
Craft accreditation	☐	☐	Other *(please specify):*					

Q. 7b How much, on average over **the last three years**, was spent directly on staff training by your company **annually**? ____

Q. 8 For each of the following statements could you please circle the number that best reflects your view on a scale of 1 to 5, where (1) is disagree strongly and (5) is agree strongly:

	Disagree Strongly	*Disagree*	*Neutral*	*Agree*	*Agree strongly*
It is important for your company to develop a network of contacts in academia	1	2	3	4	5
Developing contacts in support agencies is relevant to your company	1	2	3	4	5
If your company was to collaborate with another company, both would benefit fairly	1	2	3	4	5
The best source for innovative ideas is from within your company	1	2	3	4	5
Ongoing publicly-funded food research has significant potential application for your company	1	2	3	4	5

Q.9 Please indicate which forms of ***intellectual property protection*** your company engages in,
(Please tick all that apply):

Secret know-how ☐	Trademarks ☐	Licences ☐	Patents ☐
Non-disclosure agreements ☐	Registered design ☐	Copyright ☐	None ☐
Other: (please specify)			

Q.10 For each of the following statements could you please circle the number that best reflects your view on a scale of 1 to 5, where (1) is disagree strongly and (5) is agree strongly:

	Disagree Strongly	*Disagree*	*Neutral*	*Agree*	*Agree strongly*
Getting intellectual property protection is a complex, convoluted process	1	2	3	4	5
There is very little support for companies looking to protect their intellectual property in Ireland	1	2	3	4	5
Acquiring a patent slows down time-to-market	1	2	3	4	5
The cost of securing and maintaining a patent is more than your company can afford	1	2	3	4	5
Patents are not relevant to your company's activities	1	2	3	4	5
The secret know-how in your company contributes greatly to its competitive edge	1	2	3	4	5

Q.11 With regard to the company you work for, could you please circle the number that best reflects your view on a scale of 1 to 5, for each of the following statements, where (1) is disagree strongly and (5) is agree strongly:

In the company I work for:	*Disagree Strongly*	*Disagree*	*Neutral*	*Agree*	*Agree strongly*
senior managers are always directly involved in new product development	1	2	3	4	5
technical skills need to be enhanced to promote greater innovation	1	2	3	4	5
lack of marketing skills is a barrier to innovation within this company	1	2	3	4	5
innovation is written into the company mission statement	1	2	3	4	5
resources (time/funds) are allocated for creative work	1	2	3	4	5
change is difficult to implement	1	2	3	4	5
the unions have a strong input into employee practices and procedures	1	2	3	4	5
employees of all levels are involved in idea generation	1	2	3	4	5
employees like to maintain the status quo with regard to products and processes	1	2	3	4	5
employees are rewarded for good performance	1	2	3	4	5
employees engage readily in team work	1	2	3	4	5
there is a supportive environment for innovation	1	2	3	4	5

Q.12 Does your company have any of the following in place?

	Y	N		Y	N
Job rotation for new employees	☐	☐	Cross-functional teams	☐	☐
Mentoring/coaching for new employees	☐	☐	Internal database for sharing information	☐	☐
Intranet or internal messaging system	☐	☐	Regular cross-functional informal events	☐	☐

Q.13 Please indicate which of the following are ***priorities*** for your company *(please tick the most appropriate box for each question):*

	Not a priority	*Ongoing Priority*	*Immediate Priority (Within this mth)*	*Short term (1- 3 mths)*	*Medium term (3 mths – 1 year)*	*Long term (Over a year)*
Cut costs across the company						
Patent a company process/product						
Develop links with technology developers						
Increase market share						
Develop/increase export market						
Update current technology						
Outsource certain activities						
Promote company's brands						
Develop new products/packaging						

Q. 14 Disregarding concerns with cost, please circle the number that best reflects how likely is it that your company would adopt each of these technology on a scale of 1 to 5, where (1) is very unlikely and (5) is very likely.

(Please circle as appropriate, if you have not come across this technology please circle the corresponding 6, or if you believe that it is not relevant to your business please circle 7)

	Very unlikely	*Somewhat unlikely*	*Neutral*	*Somewhat likely*	*Very likely*	*Not aware*	*Not relevant*
High Pressure Processing	1	2	3	4	5	6	7
Irradiation	1	2	3	4	5	6	7
Radio Frequency Electric Field Processing	1	2	3	4	5	6	7
High Intensity Pulsed Light Processing	1	2	3	4	5	6	7
Ohmic Heating	1	2	3	4	5	6	7
Pulsed Electric Field Processing	1	2	3	4	5	6	7
Smart packaging	1	2	3	4	5	6	7
Modified Atmosphere Packaging	1	2	3	4	5	6	7
Nanotechnology	1	2	3	4	5	6	7
Genetically modified ingredients	1	2	3	4	5	6	7
Prebiotics/Probiotics	1	2	3	4	5	6	7
Encapsulation	1	2	3	4	5	6	7
Minimal processing	1	2	3	4	5	6	7

The particular focus of this study is <u>technological innovation</u>; we define this as the introduction/application of products, processes and packaging that are new to the company or new to market. If you have <u>not</u> introduced a technological innovation in the <u>past three years</u> please <u>skip to question 17 (Q17)</u>

Q 15. Please report on a ***recent technological innovation*** you were involved in:
What type of ***technological innovation*** was this?

Product ☐	Process ☐	Packaging ☐

*When deciding to invest in the development of this innovation which **three** of the following factors were the most important: (Please tick **three** of the following options **only**)*	
It did not require staff recruitment to use/produce	☐
It was easy to use and understand	☐
It was compatible with the current product portfolio of the company	☐
It developed the understanding of the area within the company	☐
It was trialable on a small-scale initially	☐
The benefits of the innovation were obvious to consumers	☐
It was accepted by consumers	☐
It increased market share	☐
It would result in new product/s for the company	☐
It was already being used/sold by other food companies	☐
It was difficult to copy	☐

Q.16 Please indicate (a) the degree to which you agree the following groups are of use in **your** company's ***technological innovative*** activities and (b) at what stage of the ***technological innovation*** process have you found these groups of use before, if ever *(please circle as appropriate)*:

	(a) Degree to which you agree these groups are *of use* in your company's *technological innovation* activities						**(b) What stage of taking on *a technological innovation* have you found them of use?**			
	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*		*Idea generation*	*Integration of innovation into company e.g. scale-up*	*Commercia-lising innovation e.g. new product launch*	*n/a*
Customers/ Retailers	1	2	3	4	5		1	2	3	4
Competitors	1	2	3	4	5		1	2	3	4
Suppliers	1	2	3	4	5		1	2	3	4
Universities/ 3rd level	1	2	3	4	5		1	2	3	4
Bord Bia	1	2	3	4	5		1	2	3	4
Enterprise Ireland	1	2	3	4	5		1	2	3	4
County Enter-prise Boards	1	2	3	4	5		1	2	3	4
Teagasc	1	2	3	4	5		1	2	3	4
Consultants	1	2	3	4	5		1	2	3	4
Industry Support groups e.g. ISME	1	2	3	4	5		1	2	3	4

Q.17 Does your company have a dedicated New Product Development (NPD)/Research and Development (R&D) function? Y ☐ N ☐

If yes, how many people are dedicated to this function in your company?

Full time employees _______ Part time employees_____

Please indicate the highest level of qualification of the personnel involved *(please tick):*

Secondary School ☐	3rd Level Certificate/Diploma ☐	Degree ☐	Masters ☐	PhD ☐

Q.18 Does your company have a dedicated facility for this NPD function? Y ☐ N ☐

If yes, what type of facility is it? *(Please tick all)*

	Y	N		Y	N		Y	N
Kitchen	☐	☐	Laboratory	☐	☐	Pilot Plant	☐	☐
Other (*please specify*):								

If no, what type of facility do you require?____

Q.19 What functions have input into NPD/R&D in your company *(Please tick all that apply):*

	Y	N		Y	N		Y	N		Y	N
Marketing	☐	☐	Accounting	☐	☐	Sales	☐	☐	Quality Control	☐	☐
Engineering	☐	☐	Management	☐	☐	MD	☐	☐	Purchasing	☐	☐
Production	☐	☐	Other (please specify):								

Q.20 In the last three years has your company:

Availed of Enterprise Ireland grants for R&D? Y ☐ N ☐

Availed of the R&D tax credit? Y ☐ N ☐

If yes, how much did your company spend, on average, annually on R&D? €_________________

COMPANY BACKGROUND DETAILS

Q. 21 Please indicate what **sector** your company operates in by ticking the appropriate box:

Dairy ☐	Seafood ☐	Beverages ☐	Prepared consumer foods ☐
Meat ☐	Ingredients ☐	Infant formula ☐	Fresh produce ☐
Other *(please specify):*			

Q. 22a Does your company **export**? Y ☐ N ☐

Q. 22b If yes, where do you export to *(Please tick appropriate box(es))*

	Y	N		Y	N
Great Britain & Northern Ireland	☐	☐	USA	☐	☐
Other EU countries	☐	☐	Rest of the world	☐	☐

Q. 22c What type of markets do you export to? *(Please tick appropriate box(es))*

	Y	N		Y	N		Y	N
Retailer	☐	☐	Wholesaler	☐	☐	Manufacturing company	☐	☐
Other (please specify):								

Q. 23 Please indicate the **activities** of your company by ticking the appropriate box(es):

	Y	N		Y	N
Branded goods only	☐	☐	Private label goods only	☐	☐
Mixture of branded and private label	☐	☐	Not applicable	☐	☐

Q. 24 Please indicate the approximate annual **turnover** in your company in 2009 by ticking the appropriate box:

<€2 million ☐	€2 – 9.9 million☐	€10-19.9 million☐	€20-49.9 million☐	>€50million ☐

Q. 25 Please indicate the average number of **employees** (full time equivalents) in your company in 2009 by ticking the appropriate box:

>10 ☐	10-49 ☐	50-99 ☐	100-249 ☐	250+ ☐

PERSONAL DETAILS

Q. 26 Please specify your current **job title**: ____

Q. 27 How long have you worked for **this company**: __________________________________ years
How long have you worked in the **food industry** prior to working in this company: ______years

Q. 28 Have you worked in any **other sectors** prior to the food sector? Y ☐ N ☐
If yes, which sector(s) did you work in?____

Thank you for taking the time to complete this survey. Your participation in this study is very much appreciated. If there is any further comments that you wish to make regarding your experience with technological innovation in the food industry please include them in the space provided below.

Additional comments:

This research is supported by the Department of Agriculture, Fisheries and Food under the Food Institutional Research Measure of the National Development Plan.

Appendix VII

RELAY Update "Novel food technologies – friend or for?"

New project alert

Novel food technologies – friend or foe?

We are living in a knowledge-based economy where investment in new technologies and know-how is commonplace. But will the new technology reap economic reward? In theory, it should. However, if the technology is unacceptable to consumers or industry, its full potential will not be realised. This project will assess consumer and industry acceptability of novel food technologies. The technologies to be assessed will encompass process, packaging and ingredients spanning the meat, beverage, dairy and snack-food sectors. <u>Project code CT004, first update.</u>

New know-how and technology is being researched and developed for the food industry. However, new food technologies are only successful if they are taken up by industry and accepted by consumers.

Dr Maeve Henchion at Ashtown Food Research Centre, Teagasc is association with her colleagues in University College Cork and Dublin Institute of Technology will assess consumer and food-industry acceptability of new technologies.

Consumer issues

Consumer acceptance is regularly cited as a decisive factor in the successful marketing of novel foods or foods made using novel technologies. The research team will examine a range of factors that influences consumer's opinion on novel food technologies. For instance, the consumer's definitions of novel and traditional foods will be examined, as will their awareness and perceived risks and benefits of the novel food technology. Furthermore, the influence of new knowledge and information (and the way its disseminated) on acceptability and evolution of acceptability will be examined.

Industrial issues

A number of issues will be tackled from an industrial perspective, including technological capability, cost, knowledge about the market and the risk. The scientific team will attempt to identify the market drivers and barriers that influence the industry to invest in the new technology. They will also assess intellectual property and regulatory issues which may also impact on the new technology being used.

What novel food technologies are under scrutiny?

Technologies that influence processing, packaging and ingredients from the meat, beverage, cheese and snack sectors will be addressed in this project. Key stakeholders (e.g. industry, researchers and funding agencies) will determine the specific technologies to be assessed.

Project duration: 1/10/2008 – 31/9/2011

Additional information:

Contact: Dr Maeve Henchion, Ashtown Food Research Centre, Teagasc, Ashtown, Dublin 15.
T: 01-805 9500 F: 01-805 9550
Email: maeve.henchion@teagasc.ie
Collaborating researchers: Dr Mary McCarthy, University College Cork; Dr Gwilym Williams, Dublin Institute of Technology; Dr Sinead McCarthy and Ms Bridin McIntyre, Ashtown Food Research Centre, Teagasc.

This FIRM project is funded through The Department of Agriculture, Fisheries and Food under the National Development Plan 2007-2013.

Written by Dr Breda Mulvihill, RELAY, April 2009.

Appendix VII

Cover letter accompanying first round of questionnaires

Address

Date

RE: National Survey of Food Companies' Innovation Activities

Dear____________,

Thank you for taking the time to read my communication. I am contacting you to ask for your help in completing a brief questionnaire. The survey forms part of a project which seeks to identify the key factors influencing new technology uptake by Irish food companies. It is a partnership between Teagasc (Ashtown Food Research Centre), the Dublin Institute of Technology and University College Cork, and is funded by the Department of Agriculture, Fisheries and Food. It is my hope that the findings of this work will benefit the future competitiveness of Irish food enterprises, thereby supporting the national recovery.

I would be grateful for your time in filling out the enclosed questionnaire, which should take about 15 minutes to complete. Instructions for completing the questionnaire can be found on the form itself. There are no right or wrong answers and all information received will remain strictly confidential.

A FREEPOST envelope is enclosed for your convenience, and return of completed questionnaires by Wednesday the 21st of July would be greatly appreciated.

You can contact me or Dr. Maeve Henchion to answer any questions or concerns you may have regarding the questionnaire or the overall project. Our contact details are tel: 01-8059500; email: grainne.kavanagh@teagasc.ie or maeve.henchion@teagasc.ie.

Yours sincerely,

____

Gráinne Kavanagh,
Food Market Research Unit,
Ashtown Food Research Centre, Teagasc

Appendix VIII

Reminder letter to complete questionnaire

Address

Date: 21/07/10

RE: National Survey of Company Innovation Activities

Dear________,

We recently sent you a request to participate in a survey relating to Irish food companies' innovation activities. If you completed the survey we are very appreciative of your input. If you have not yet had the opportunity to complete the survey we would be most grateful if you could assist us as we want the survey to be as representative as possible of industry views and opinions. This will enable us to make recommendations that will be of maximum benefit to the industry. Thus, your participation is essential to this nationally important research. Please be assured that your contribution will be held in the strictest confidence.

If you did not receive a questionnaire or have misplaced it, please contact us at the below contact details and we can send you another copy. Our contact details are tel: 01-8059500; email: grainne.kavanagh@teagasc.ie or maeve.henchion@teagasc.ie.

The date for receipt of questionnaires has been extended until July 28th.

Thank you for your time,

Kind regards,

____

Gráinne Kavanagh,
Food Market Research Unit,
Ashtown Food Research Centre, Teagasc

Appendix IIX

Cover letter accompanying second round of questionnaires

Address

Date

RE: National Survey of Food Companies' Innovation Activities

Dear___________

A few weeks ago, we sent you a questionnaire asking about your opinions on innovation in the Irish food industry. At this stage, our records show that your questionnaire has not yet been returned.

We are writing to you again, due to the importance of your responses to the questions we are asking. By receiving responses from everyone who was selected, we can be sure that our results give a true picture of innovation in the food industry. This will help us formulate recommendations that will benefit the future competitiveness of Irish food enterprises, thereby supporting the national economic recovery. Please be assured that your contribution will be held in the strictest confidence.

We have enclosed a second copy of this questionnaire and FREEPOST envelope. We would be grateful if you would complete and return this to us as soon as possible. If there is some reason you prefer not to answer it, please let us know by returning a note or the blank questionnaire in the FREEPOST envelope or contact us at tel: 01-8059500; email: grainne.kavanagh@teagasc.ie or maeve.henchion@teagasc.ie.

Kindest regards,

____

Gráinne Kavanagh,
Food Market Research Unit,
Ashtown Food Research Centre, Teagasc

Appendix IX

Interview guide for second round of semi-structured interviews (industry)

<table>
<tr><td colspan="2">THANKS
AIM: investigate innovation in the Irish food industry.
Confidential. Also, if you wouldn’t mind, I would like to record the conversation so I don’t miss any of your comments. Is this ok with you?</td></tr>
<tr><td colspan="2">INTRODUCTION OF INTERVIEWER
Do you mind if we start with what your role is here (day to day) and the responsibilities you have?</td></tr>
<tr><th>Main questions</th><th>Additional questions (Brackets indicates supplementary questions)</th></tr>
<tr><td>Innovation
I am interested in finding out what the term innovation means to different people. (What key words come to mind when you consider innovation in your company?)
Can you tell me about any innovations your company has been involved in the last few years?

Innovation
Different, before, radical
Importance
Who – key players
MD
Cross functional
NPD/R&D
Culture
Typical/differences</td><td>Had the company attempted anything like this before? Was anything like this attempted before in other Irish companies? Or in other countries? Is this typical of what you’ve be doing in the last five years? Who was involved? Who were the keys players? New ideas? Always the same? How well does this process work? Cross-functional teams? Culture of innovation?
In your opinion, to be to be considered an innovation, how different would a new product have to be from existing products on offer? (What would have to be different about a product or a process to be deemed an innovation? line extension, flavouring change)
(Would you see any difference in an innovation that was ‘new to company’ and ‘new to market’?)
What would a radical food innovation mean to you (either in terms of a radical product or a radical process)? (Can you give me an example of a product, that either this or another food company produces, which you would consider radical? Can you think of an example of a food process that you would consider radical?)
How important is it for your company to be innovative in terms of products or processes or packaging? Where do you think the drive to bring out new products come from? Who? What?
How involved are you/the MD in NPD or R&D? (Do you think it is important for the MD/you to be involved in NPD? Why?) Who is responsible for bringing new ideas into the company/seeing what competitors are up to? (How is that type of competitive intelligence shared within the company? - Regular meetings or results presented to the MD - Who makes the final decision on what to go with? From your experience, it this typical of the industry? What differences exist in other food companies?)
Do you have an NPD or an R&D function here? Is on an occasional basis or is it continuous? (What would be the difference between NPD and R&D in your opinion? Discuss level of R&D)
Do you have cross-functional teams in this company? (Who is involved in such teams? How effective do you think they are? (Engineer) From your experience, it this typical of the food industry? What differences exist in other food companies?)
Would you say this company has a culture for innovation? (What has contributed to that? What factors do you think have an impact on an innovation culture? What drives the culture? Is there anything that negatively impacts on the culture in this or other firms that your colleagues in the industry may have mentioned?)</td></tr>
</table>

- What are you taking on a new **technological innovation,** what **benefits** are you looking for? Benefits Parameters	- Are you interested in a **solution to a problem** or in **creating something new**? Can you give me an example of the type of **parameters** or measures that they are using to assess the benefit of a technology? (*E.g*. what ROI are you looking for?) - How important is a reduction in average **cost of products** produced? (factors of production *e.g*. manpower use, material consumption, energy consumption) - Do you know what **share of sales** (and exports) are due to technologically innovative products put on the market? - What **benefits** are you looking for (increased operating margin, extend product range, market share increase/maintain, open new markets, increase production flexibility, lower labour costs, lower energy consumption, lower raw material consumption, lower reject rate, lower product design costs, reduction in production lead times, improve product quality, improve working conditions)?
- Has this company changed its **packaging** in the last few years? Why Drive from where Decided on this External agencies of help Market research	- **Why** did you change the packaging format? **Where** did the drive to change the packaging come from? (Where did the **idea** for the new type of packaging come from?) - How did you **decide** to go with that type of packaging format? (In your opinion, **who** has the most impact on what type of packaging you choose? Suppliers/retailers/customers? From your experience, it this typical of the food industry?) - Did you get any **external** help with this new packaging concept? Who was involved? Consultants/support agencies/TLIs? Do you think any of these (Consultants/support agencies/TLIs) could have been of help when you were changing the packaging? - Did you conduct any **market research** around this new design? What type of market research do you normally conduct? (What is involved? What do you mean by ‘in-house’? From your experience, it this typical of the food industry? What differences exist in other food companies?)
Support agencies and publicly funded research organisation - In your opinion, how satisfied are you or your colleagues with the **state funded support** available to Irish food companies in terms of technological innovation support? Size Proximity Export Sector Regulation	- Do you think the **size** of this company has an impact on what is available to you? - Do you think **proximity** to research institutes influences this? - Is this different for some **sectors** of the industry? How is this sector different to other sectors? - In your opinion, are there differences in the way technological innovation in companies which **export** are supported? - How relevant or appropriate are R&D **tax incentives** to your activities here? (In your opinion, how widely available is information on this type of incentives? How would you suggest improving this?) - Food companies have quite a lot of **regulation** to adhere to. Do you find any particular regulations impact on your firm in terms of tech innovation? (Can companies’ access information and expertise to help with this? Are there any ways this could be improved?) - In your opinion, how satisfied are your colleagues with the **training** that is available to Irish food companies in terms of tech innovation? What do you focus your training expenditure on? (Have your training costs increased over the years? Are there gaps in the process of NPD/innovation that you think training could

Training Technical qualifications Agencies	help with? What type of training would you like to see available?) - How important is the level of **technical qualifications** in terms of the people you employ? (In your opinion, how satisfied are you and your colleagues with technical **graduates** that come out of research institutes or TLIs in Ireland?) - What **agencies** have you worked with here? (Would you have found them useful? Is there anything else they could have done, or changed that would have been helpful?)
- Have you a working relationship with anyone working in a **third level institute** or research organisation?	- **How** did the relationship come about? **What** is involved in this relationship? (Is it formal or informal? What is the best way? Are you involved in or planning any **future** projects together?) - In your opinion, has this relationship been **beneficial**? (In what way? What do you think drives food companies to get involved with research institutes? How would you suggest new business would develop relationships like these?) - Do you think it is **important to be involved** with TLI or research organisations? (How important is it to get ideas from external sources/to look outside the company for ideas?) - Are there any **issues** that arise with this sort of relationship? (Are there any difference between those working in industry and those working in research organisations?)
External environment Looking at the different factors in the **business environment**, what stands out as the biggest issue for you in terms of supporting/constraining tech innovation?	- How much **control** do you feel you have over this issue? - Are there **other issues** that you think have a big impact? - What **impact** does this have on your company's activities re tech innovation? Encourage or inhibit? - What do you think can be done about this issue?
Conclusion of interview Are there any other issues that we have not discussed and that you find worrisome?	

Appendix X

Interview guide for second round of semi-structured interviews (non- industry)

<table>
<tr><th colspan="2">INTRODUCTION OF INTERVIEWER</th></tr>
<tr><td colspan="2">I want to thank you for taking the time to meet with me today. The project I am working on aims to investigate innovation in the Irish food industry. As your have been involved in projects involving industry, I am delighted to get the chance to talk to you today. As I said in the letter, all responses will be treated in the strictest confidence. Also, if you wouldn’t mind I would like to record the conversation so I don’t miss any of your comments. Is this ok with you?
Do you mind if we start with what your role is here and the responsibilities you have?
Have you been involved in any projects which involved technological innovations in industry (a new product idea/manufacturing process/packaging format)?</td></tr>
<tr><th>Main questions</th><th>Additional questions</th></tr>
<tr><td>Innovation
• I am interested in finding out what the term innovation means to different people, what key words come to mind when you consider innovation in the context of the food industry?</td><td>• Was anything like this attempted before in Irish companies? Or in other countries?
• If an innovation was ‘new to industry’ what would that mean to you? Would you see any difference in an innovation that was ‘new to company’ and ‘new to market’?
• In your opinion, to be to be considered an innovation, how different would a new product have to be from existing product on offer? What would have to be different about a product or a process, to be termed an innovation? (line extension, flavouring change)
• What would a radical food innovation mean to you (either in terms of a radical product or a radical process)? Can you give me an example of a product that either this or another food company produces that you would consider radical? Can you think of an example of a food process that you would consider radical? Clarify.
• How important is it for Irish food companies to be innovative in terms of products or processes or packaging? Where do you think the drive to bring out new products come from? Who? What?
• In your experience are the companies you have worked with mostly led by one personality or are a committee of decision makers involved in NPD? (size of the company) Do you think it is important for the MD to be involved in NPD? Why? In the companies you have worked with, who was is responsible for bringing new ideas into the company/seeing what competitors are up to? How was that type of competitive intelligence shared within the companies? Who makes the final decision on what to go with? From your experience, it this typical of the food industry?
• In the companies you have worked with, is there any evidence of cross-functional teams? Who would be involved in these teams? How effective do you think they are? (Engineer) From your experience, it this typical of the food industry?
• Something that came out quite strongly in our survey was the importance of a culture of innovation within a company for driving change. In your experience, are Irish food companies open to change? Would you say there is a culture of innovation in many Irish firms? What has contributed to that? What factors do you think have an impact on an innovation culture? What drives the culture? Is there anything that negatively impacts on the culture?
• In your experience do companies have formal strategies in place?</td></tr>
</table>

	E.g. an innovation strategy or a human resources development strategy? What is meant by a ‘formal strategy’? How would it be implemented? (Do you think the way companies are structured has changed much in recent years?) - What are you discussing new technologies with firms what benefits are they interested in hearing about? Can you give me an example of the type of parameters or measures that they are using to assess the benefit of a technology? E.g. ROI A solution to a problem or something new? Competitive edge?
- Moving on to packaging innovations in particular, have you come across any new packaging you though was particularly innovative?	- **In companies, where** does the drive to change the packaging come from? Where did the **idea** for the new type of packaging come from? - In your opinion, **who** has the most impact on what type of packaging chosen? Suppliers/retailers/customers? From your experience, it this typical of the food industry? Would any of the industry support agencies or TLI have expertise in packaging innovation that could be of use to companies? - Moving on to market research. How active are the companies you have been involved with **market research**? What type of market research do they normally conduct? What do you mean by ‘in-house’? What is involved? From your experience, it this typical of the food industry?
Support agencies and publicly funded research organisation Generally speaking, how satisfied are the companies you are involved in, with the state funded support that is available?	If not, what are the main problems that you have come across or heard about?
	- Do you think the size of companies has an impact on what is available? - Do you think **proximity** to research institutes has an influence on this? - Is this different for some **sectors** of the industry? How is the sector you support different to other sectors? - In your opinion, are there differences in the way technological innovation in companies which **export** are supported? - What is your opinion on the **tax incentives** that are available to Irish food companies? How widely available is information on this type of incentives? How would you suggest improving this? - Food companies have quite a lot of **regulation** to adhere to. Do the companies you work with mention any particular regulations as impacting on tech innovation? Can companies’ access information and expertise to help with this? Are there any ways this could be improved? - In your opinion, how satisfied are the companies you advise with the **training** that is available to Irish food companies in terms of tech innovation/abs capacity? What do companies focus their training spend on? Are there gaps in the process of NPD/innovation that you think training could help with? What type of training would you like to see available? - In your opinion, how satisfied are Irish food companies with technical **graduates** that come out of research institutes or TLIs in Ireland? How important is the level of technical qualifications to companies in the sector you support? - Have companies mentioned to you other agencies they find particularly helpful? Any agencies they have had issues with?
- From our	- How did the relationship come about? What is involved in this

discussion earlier it is apparent that you have you a working relationship with a number of people in Irish food SMEs? OR - Looking at the relationships between Irish food companies and support agencies?	relationship? Is it formal or informal? What is the best way? Are you involved in or planning any future projects together? - In your opinion, has this relationship been beneficial? In what way? What do you think drives food companies to get involved with research institutes? How would you suggest new business would develop relationships like these? - Are there any issues that arise with this sort of relationship? Are there any difference between industry and those working in research organisations? In terms of expectations (culture or time constraints)? - How important is it for food companies to get ideas from external sources? Do you think it is important for companies to be involved with TLI or research organisations?
External environment - Looking at the different factors in the business environment that impact on Irish food companies, what stands out as the biggest issue for you?	- How much impact does this have on company activities re tech innovation? Encourage or inhibit? - Do you think companies have control over these issues? - Are there other issues that you think have a big impact? - What do you think can be done about this issue?
Conclusion of interview Are there any other issues that we have not discussed and that you find worrisome?	

Appendix XI

Initial approach letter for second round of semi-structured interviews

Address

Date

RE: Study to support the innovation capacity of Irish Food Companies

Dear________,

I am conducting a number of interviews with leaders in the food industry to examine the nature of innovation in Irish food companies. The interviews are being conducted as part of a partnership study between Teagasc (Ashtown Food Research Centre) the Dublin Institute of Technology and University College Cork, funded by the Department of Agriculture, Fisheries and Food. The findings of the study will provide recommendations for government support agencies and research institutes on how best to support innovation in Irish food companies. Targeted development of innovation capacity will facilitate the competitiveness and sustainability of the food industry, thereby supporting the national recovery. To date we have conducted a large-scale survey of Irish food companies. The results of this survey are very interesting. However, we would like to complement these findings by some more detailed discussions with those operating on the ground.

We would like to interview you because…. *to the long running work in innovation and your recent winning of…).* The interview will take approximately one hour. All information provided by you will be treated in the strictest of confidence and individual/company names will not be used in the final report. Your input would make a valuable contribution to the study and greatly help in ensuring the results of the study are of benefit to the industry.

I will contact you early next week by phone to discuss the possibility of an interview. In the meantime, if you should have any queries regarding the project please contact either Dr. Maeve Henchion or myself. Our contact details are tel: 01-8059500; email: grainne.kavanagh@teagasc.ie or maeve.henchion@teagasc.ie.
I look forward to speaking with you.

Yours sincerely,

____

Gráinne Kavanagh,
Food Market Research Unit,
Teagasc Food Research, Ashtown